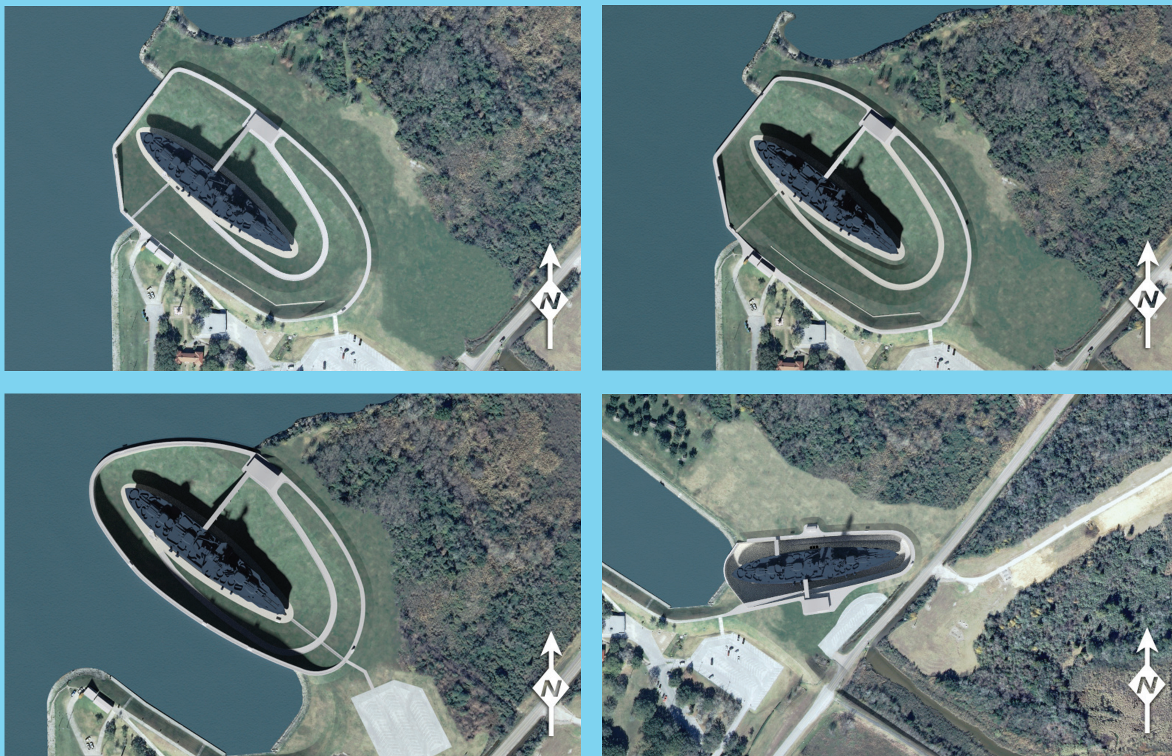


# Dry Berth of Battleship TEXAS State Historic Site

## Phase I: Conceptual Design Report

TEXAS PARKS & WILDLIFE

AECOM

September 2011

AECOM
5757 Woodway Drive
Suite 101, West
Houston, TX
www.aecom.com

713.780.4100 tel
713.278.4635 fax

September 29, 2011

Neil Thomas, RLA, PMP
Project Manager, Region II
Infrastructure Division
Texas Parks & Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Dear Mr. Thomas:

Enclosed is the complete report for Phase I Battleship TEXAS Dry Berth Project. The first four pages provide an “At a Glance” overview, followed by an expanded Executive Summary and then full report. The Phase I effort focused primarily on conceptual design of dry berth options, evaluation of ship condition, cost estimates for the dry berth options and preliminary regulatory coordination.

The AECOM Team is privileged to have been entrusted with this important project and we thank Texas Parks and Wildlife Department for the opportunity. We are pleased to submit our comprehensive findings in this Phase I report.

Sincerely,

JAWAD M. FARHAT

Jerry Farhat, PE
AECOM Project Manager
jerry.farhat@aecom.com

# BATTLESHIP TEXAS
# Dry Berth Project

Project 101887

Life's better outside.®

## AT A GLANCE...

### Dry Berth of the Battleship *Texas* Phase I Conceptual Design Report

### WORK PERFORMED BY AECOM

- ☑ Evaluated current condition of Battleship TEXAS
- ☑ Conducted studies and surveys (including geotechnical, topographical, bathymetric, preliminary natural resource and archeological data collection)
- ☑ Developed dry berth siting constraints
- ☑ Began regulatory coordination
- ☑ Initiated stakeholder outreach
- ☑ Evaluated 2008 report by Proceanic, LTD on dry berth options
- ☑ Identified potential temporary berthing locations to be used by TEXAS during construction of the permanent dry berth and developed preliminary designs and cost estimates for each
- ☑ Developed four conceptual dry berth options and cost estimates for each
- ☑ Developed estimated life-cycle costs for each of the four dry berth conceptual designs
- ☑ Generated estimates for anticipated costs for "standard" dry-docking operations for the next 30 years assuming TEXAS is not placed into a permanent dry berth

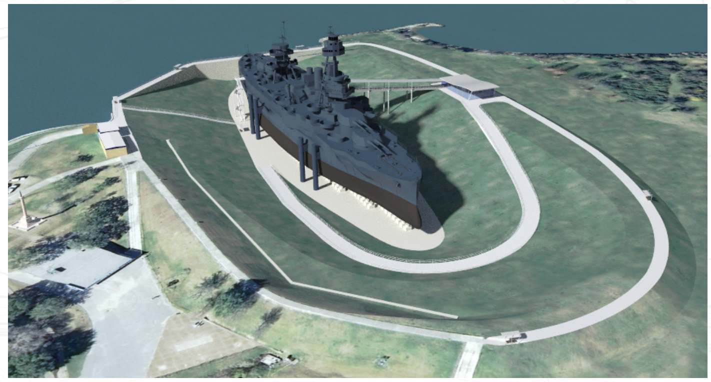
### OPTIONS DEVELOPED BY AECOM

Through an exhaustive and collaborative process in which multiple alternatives were evaluated, four options are presented in a summary document called the Conceptual Design Report. Development of these options was done in compliance with three requirements set forth by TPWD. Each solution:

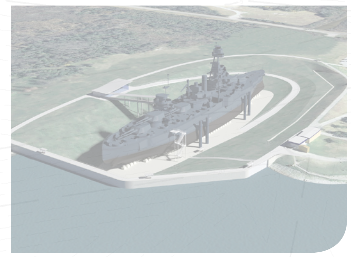
- Must be, within reason, reversible,
- Must visually respect the San Jacinto Battleground State Historic Site, and
- Must provide a less-expensive long-term alternative to conducting a major drydocking every 10 to 15 years.

*The dry berthing design options displayed are conceptual designs for the consideration and review of TPWD.*

## *Option 1*







**Site:**
Existing berthing location

**Elevation of Basin Slab:**
26 feet

**Elevation of Ship:**
5 feet higher than existing height

**Ship Location during Construction:**
On-site superflooded wet berth

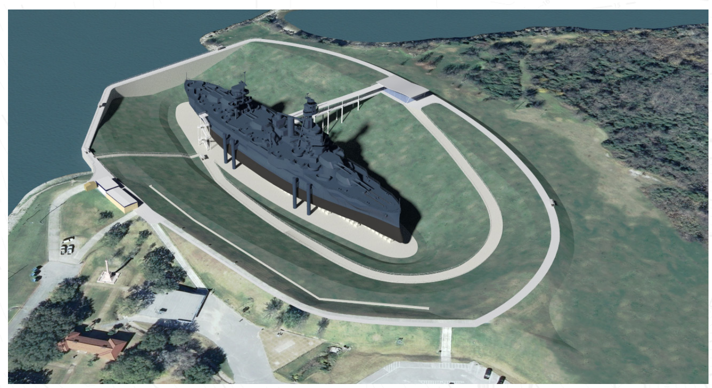
**Construction Type:**
Sloped earthen revetments

**Visitor Access during Construction:**
No

**Ship Entrance into Houston Ship Channel Required:**
No

**Estimated Cost:**
$38.2 million [1, 2]

## *Option 2*





**Site:**
Existing berthing location

**Elevation of Basin Slab:**
38 feet

**Elevation of Ship:**
7 feet lower than existing height

**Ship Location during Construction:**
On-site wet berth (not superflooded)

**Construction Type:**
Sloped earthen revetments

**Visitor Access during Construction:**
No

**Ship Entrance into Houston Ship Channel Required:**
No

**Estimated Cost:**
$46.3 million [1, 2]

## Option 3

**Site:**
Existing berthing location

**Elevation of Basin Slab:**
38 feet

**Elevation of Ship:**
7 feet lower than existing height

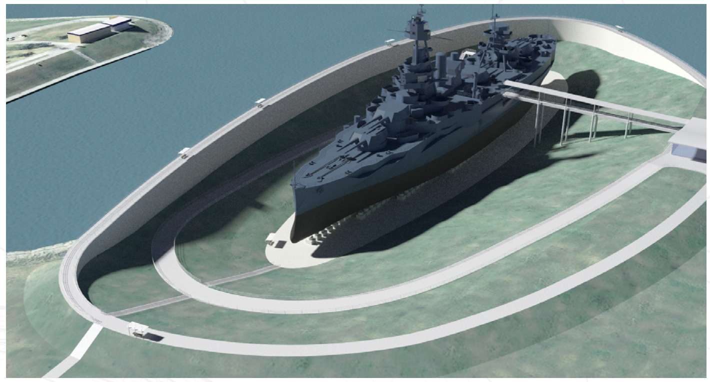
**Ship Location during Construction:**
Existing berth

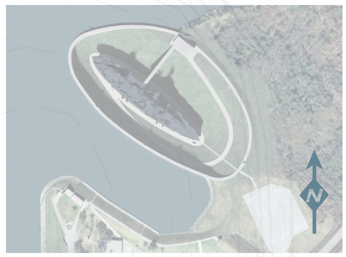
**Construction Type:**
Sloped earthen revetments

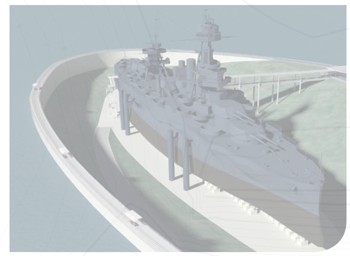
**Visitor Access during Construction:**
Yes

**Ship Entrance into Houston Ship Channel Required:**
Yes

**Estimated Cost:**
$41.1 million [1, 3]





## Option 4

**Site:**
Existing berthing location

**Elevation of Basin Slab:**
38 feet

**Elevation of Ship:**
7 feet lower than existing height

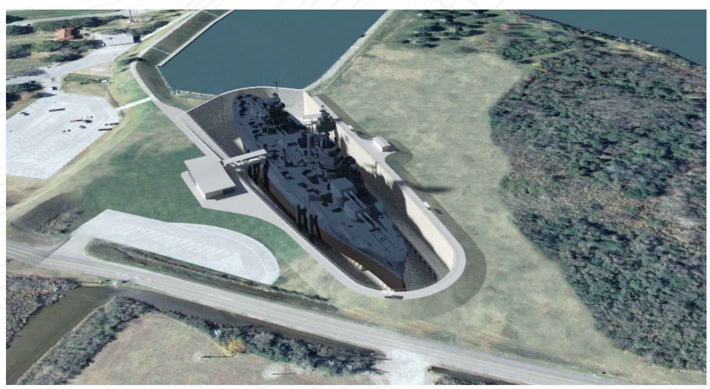
**Ship Location during Construction:**
Existing berth

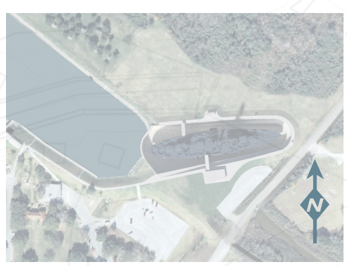
**Construction Type:**
Reinforced concrete slurry wall/ cantilevered steel king pile wall

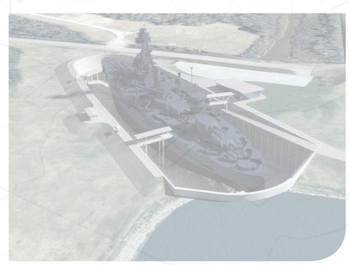
**Visitor Access during Construction:**
Yes

**Ship Entrance into Houston Ship Channel Required:**
No

**Estimated Cost:**
$49.3 million [1, 3]





*Footnotes:*
1. *Estimated costs shown do not include repairs to the ship.*
2. *Costs for Options 1 and 2 include providing an on-site temporary berthing facility.*
3. *Options 3 and 4 do not require a temporary berthing facility.*

## SUMMARY OF KEY FINDINGS OF AECOM

- ✯ The condition of the ship has worsened since the last inspection in 2008 as AECOM identified critical problems with vessel stability and structural integrity. Any attempt to refloat or tow the ship, without performing critical repairs to the hull and portions of the internal ship structure, would be very risky and is likely to cause irreparable damage to the ship.

- ✯ It is inadvisable and dangerous to attempt to tow the ship into the Houston Ship Channel due to her condition and the importance of the channel to commerce. Operators along the channel have raised concern about catastrophic impacts should the ship become grounded and obstruct the channel. Such an obstruction could seriously disrupt the operation of the Port of Houston, resulting in an estimated $1 billion/day in economic losses and claims.

- ✯ The dry berth options presented in the 2008 Proceanic report:
  - Were developed without the benefit of any geotechnical information.
  - Included only two suitable options, both of which were based on the assumption that TEXAS would be towed to a temporary berthing facility during dry berth construction, but significantly underestimated the cost of that facility.

- ✯ Cost estimates for the AECOM permanent dry berth options are in the same range as the 2008 Proceanic options and other dry berth construction projects.
  - Costs for Options 1 and 2 include approximately $14 million for a temporary on-site berthing location, while the estimates in the Proceanic report were approximately $900,000.
  - Costs for Options 3 and 4 do not require a temporary berth, as these options do not require that TEXAS be moved from her current location during construction.

# Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

# 1 EXECUTIVE SUMMARY: PHASE I CONCEPTUAL DESIGN PHASE

The Texas Parks and Wild Life Department (TPWD) has been challenged with a huge and inspiring undertaking, the preservation and protection of the historic battleship TEXAS. The agency's task as mandated by the Texas Legislature and the Legislative Budget Board is to place the TEXAS in permanent dry berth.

The Battleship TEXAS and the San Jacinto Battleground SHS (State Historic Site) are icons of Texas and major tourist attractions with visitors from around the world. TPWD entered into a professional engineering services contract with AECOM for the first two phases of a six phase development of the project, namely:

- Phase I: Conceptual Design
- Phase Ii: Section 106 and NEPA Review

The scope of work for Phase I of the project includes the following tasks:

1. Conduct Studies/Surveys Including:
    a. Topographic
    b. Bathymetric
    c. Geotechnical
    d. Natural Resources Studies (Natural Resources, Environmental)
    e. Cultural Resources (Archeological)
    f. Other Studies
        i. Ship Characteristics
        ii. Design Water Levels
        iii. Ship Block Height
        iv. Ship Stability and Draft Assumptions
    g. Landscape Architecture
    h. Civil /utilities
2. Evaluation of Proceanic Dry Berth Options (2008)
3. Development of AECOM Options
4. Prepare Capital and Life Cycle Cost Estimates for Each Option
5. Evaluate the Ship's Condition
6. Coordinate Regulatory Reviews and Requirements: Public Involvement Plan
7. Present Options and Recommendations to TPWD Staff And Others
8. Identify and Make Preliminary Design Preparations and Cost Estimates for a Temporary Facility to Dock the TEXAS During Construction
9. Finalization and Reporting to TPWD

The following sections present the most important results of the conceptual design phase.

## 1.1 DRY BERTH OPTIONS DESCRIPTION

The dry berth alternatives evaluation consisted of the following developmental sequence:

- Alternatives within the existing basin consisting of series 1.1, 1.2, etc.
- Alternatives north of the existing basin consisting of series 2.1, 2.2, etc.
- Alternatives east of the existing basin consisting of only one option 3.0

Eight feasible alternatives made the preliminary list and four made the final list which is presented in the conceptual design report. The final four alternatives are:

- Alternative 1.2.1 (Option 1)- landscaped dry berth in existing Basin using superfolooding
- Alternative 1.3 (Option 2)- landscaped dry berth in existing Basin without superfolooding
- Alternative 2.2B (Option 3)- landscaped dry berth north of existing basin
- Alternative 3.0 (Option 4)- conventional drydock northeast of existing basin

A summary of the final dry berth alternatives is shown in Table 1-1.

**Table 1-1: Summary of Dry Berth Alternatives**

| Alternative | Components | | | Elevations of Dry Berth | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | West Closure | North Wall | South Wall | Top of Wall | Top of Dike | Top of Basin Slab | Main Deck Elev. at Gangway[1] | Diff Elv Between Existing & Proposed | Ship Location During Construction | |
| Existing | N/A | N/A | N/A | N/A | N/A | N/A | +25 | | N/A | Main deck elevation varies with tide; +30' at MSL[2] |
| Alternative 1.2.1/ Option 1 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -26 | 30 | 5 | Onsite superflooded wet berth | Wet berth offset 20' north of present berth |
| Alternative 1.3/ Option 2 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -38 | 18 | -7 | Onsite wet berth, not superflooded | Dry berth offset 45' north to protect existing south bulkhead from deep excavation. Wet berth parallel to present berth, offset 65' north |
| Alternative 2.2B/ Option 3 | King Pile Wall | Earth revetment | King Pile Wall | +13 | +14 | -38 | 18 | -7 | Existing berth | Berth excavated onshore, north of existing berth |
| Alternative 3.0/ Option 4 | King Pile Wall | Anchored slurry wall | Anchored slurry wall | +13 | 14 | -38 | 18 | -7 | Existing berth | Berth excavated onshore, northeast of existing berth |

Notes:
1: Assumes deck height 50' above keel. For dry berths, assumes 6' block height. For existing wet berth, assumes tide at MSL.
2: MSL: Mean Sea Level

Option 1 would utilize TEXAS current berth location for construction of the dry berth. A cantilevered king pile bulkhead would separate the wet berth from the waters of the Houston Ship Channel, and sloped earthen revetments, or retaining walls, would be excavated around the perimeter of the dry berth. The layout would retain the existing south side bulkhead.

During construction, the battleship would be transferred to a temporary wet berth located east of her current position by using onsite superflooding of the wet and excavated berth and keeping the wet berth superflooded (+12') during the construction period until retransferred to the constructed dry berth. This wet berth would be comprised of temporary sheet piles and located just west of Independence Parkway. This temporary berthing option precludes risks associated with towing TEXAS into the Houston Ship Channel, and it provides a direct, straight pathway for TEXAS into and out of the wet berth. See Figure 1-1.

Option 2 is similar to the previous option, but without superflooding. It also includes vegetated, sloped revetments constructed within the site of TEXAS' current wet berth. Without the process of superflooding, this option would require a deeper foundation at Elevation -38 feet, 12 feet lower than Option 1. Because of this added depth, the width of the entire dry berth would be greater, and there would be larger land-side impacts directly north of the existing berth. See Figure 1-2.

Option 3 offers a different siting location, utilizing land just north of the current mooring location. Like Option 2, a foundation depth of -38 feet is needed. This option has the largest land-side impact of the alternatives presented here, and has wetland impact as well. See figure 1-3.

Unlike the previous options presented, TEXAS would remain in her existing location during construction, with only minimal modifications to existing ship utility services required. Besides reducing the amount of temporary work needed, this feature would allow TEXAS to remain open to visitors throughout the dry berth construction process. The dry berth construction would likely be an interesting attraction for visitors to the ship.

Option 4 differs from the previous alternatives in terms of structural design and placement of the battleship itself. The dry berth would be constructed northeast of the existing mooring location, and would be constructed using an anchored reinforced concrete slurry wall around the perimeter of the berth and a cantilevered steel king pile wall at its entrance. The ship would be berthed diagonally in relation to her current position, and she would be dry berthed in close proximity to Independence Parkway. See Figure 1-4.

This option would result in the smallest footprint, and it would also allow TEXAS to remain at her existing mooring during construction. As in Option 3, visitors would be allowed on the vessel throughout the dry berth construction process.

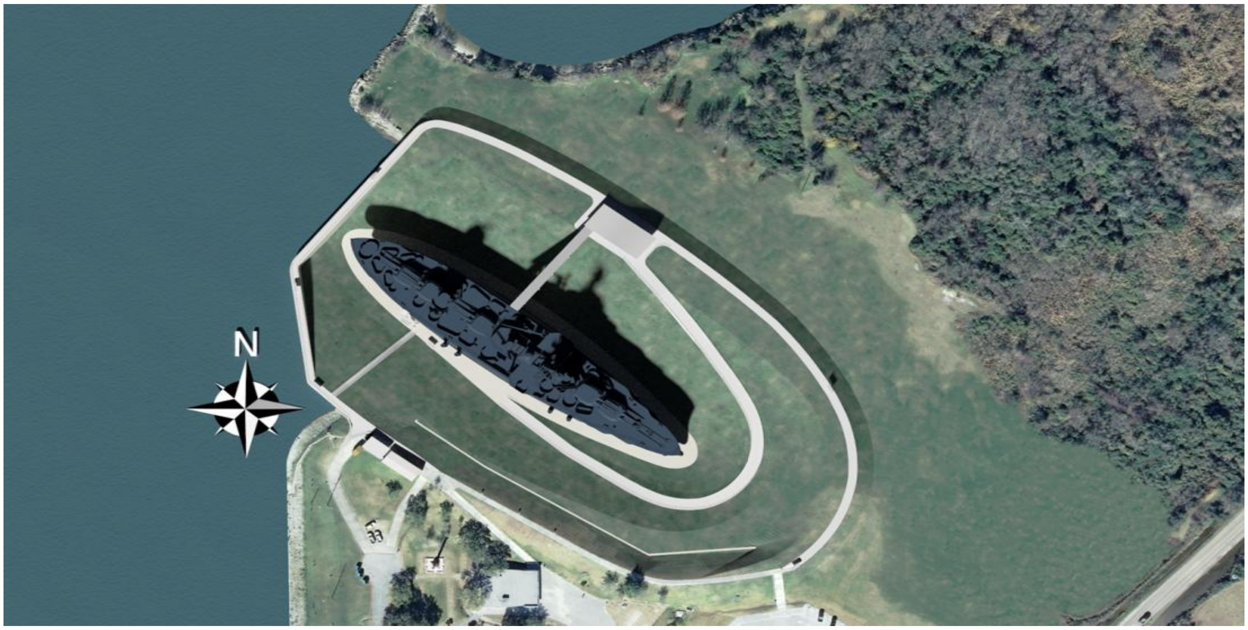



Figure 1-1: Dry Berth Option 1 View 1


Figure 1-2: Dry Berth Option 1 View 2

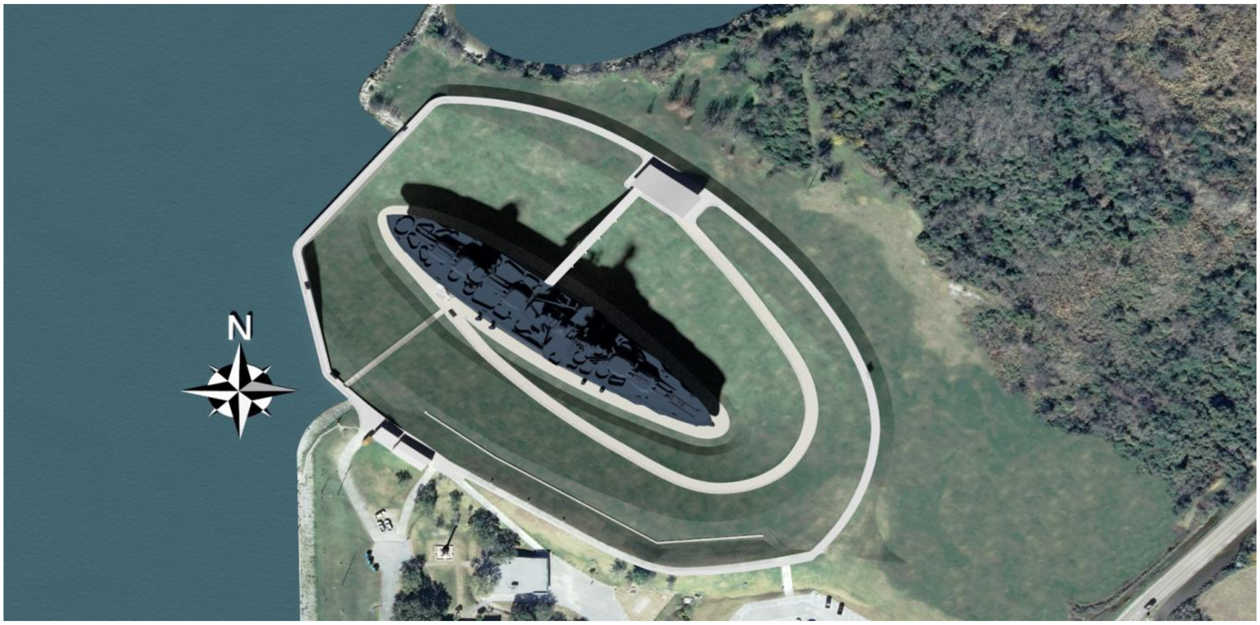



Figure 1-3: Dry Berth Option 2 View 1


Figure 1-4: Dry Berth Option 2 View 2

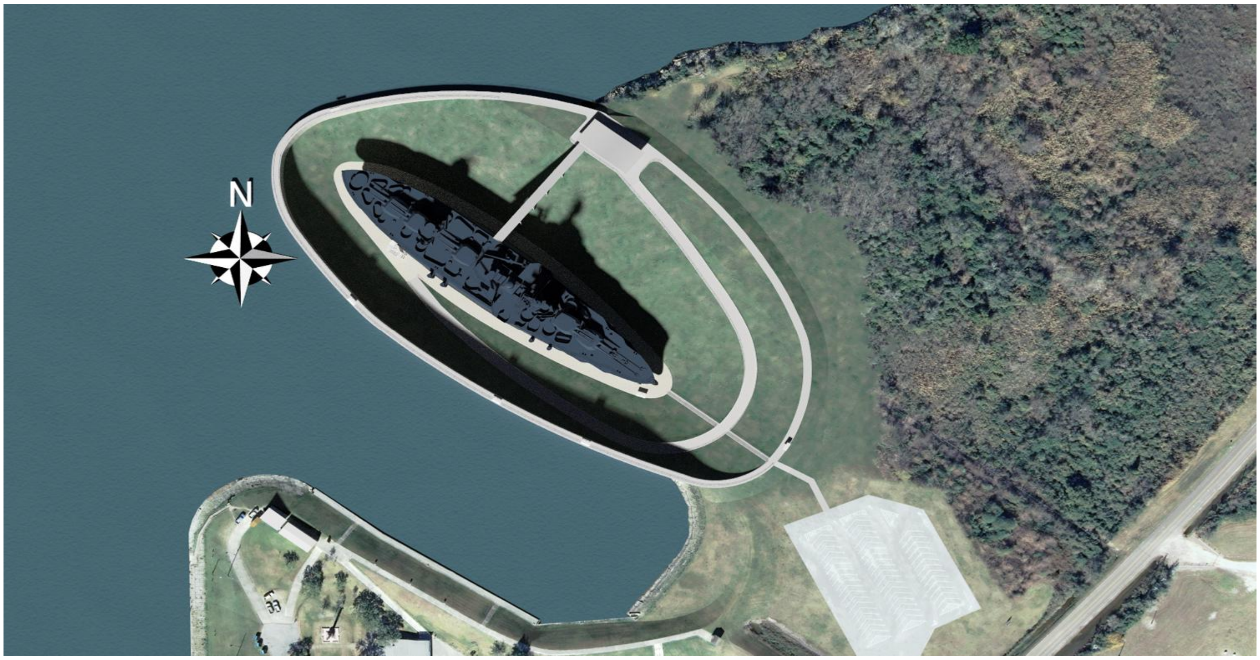



Figure 1-5: Dry Berth Option 3 View 1

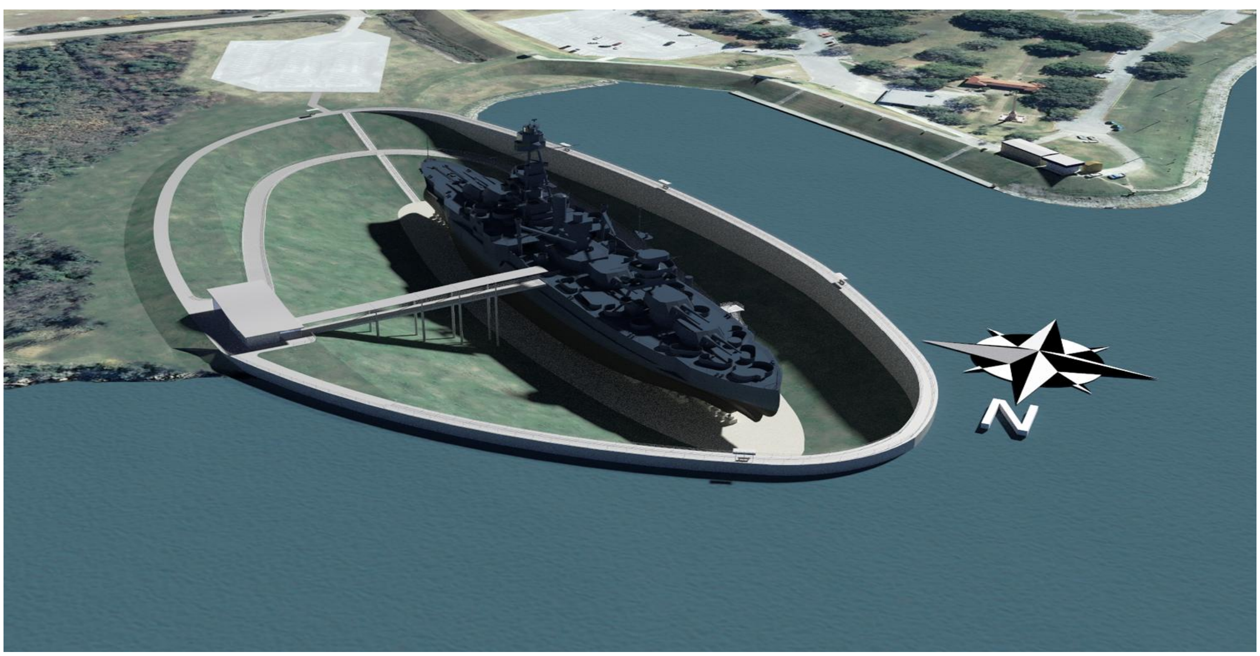



Figure 1-6: Dry Berth Option 3 View 2

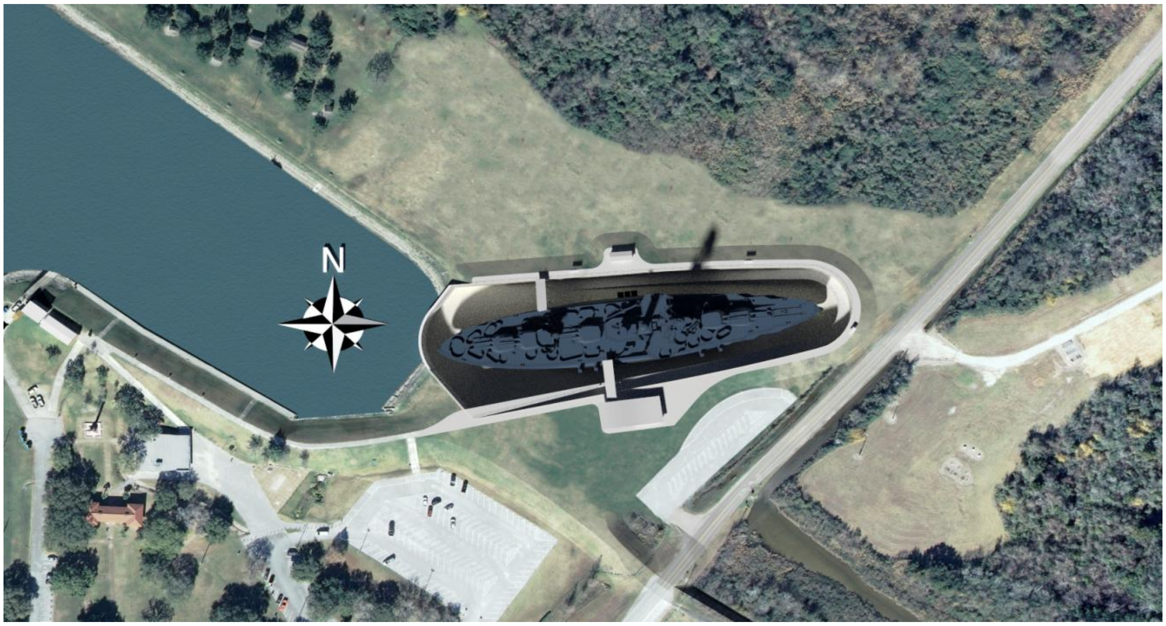



Figure 1-7: Dry Berth Option 4 View 1

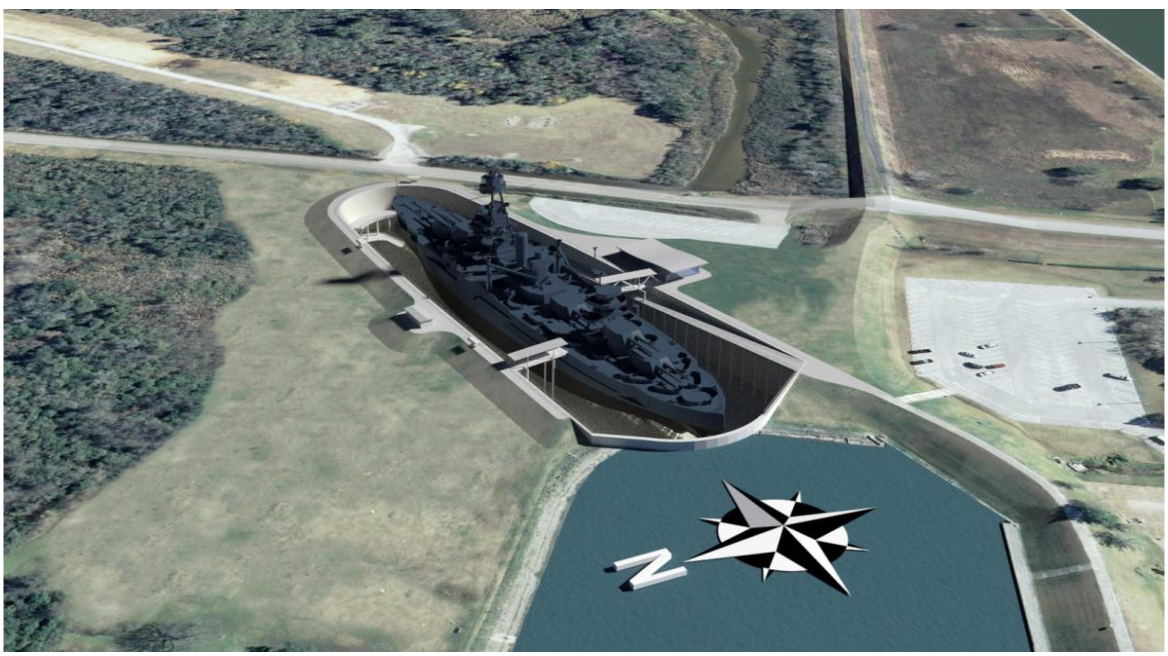



Figure 1-8: Dry Berth Option 4 View 2

## 1.2 DRY BERTH OPTIONS COST ESTIMATES

Capital cost estimates were based on the following assumptions:

1. Calculations including quantity take-off for major elements of the project required to construct the design
2. Cost assumptions for material and equipment
3. Unit cost data
4. Contingency factors
5. Construction cost indices to update costs from data source
6. Use of local cost data where feasible
7. Capital cost estimates exclude TPWD construction management costs
8. Capital cost estimates excludes ship repair costs

Cost summaries are shown in the following tables and figures:

- Table 1-2: Capital Cost Summary for Alternatives With Temporary Wet Berth
- Figure 1-5: Capital Cost Summary for Alternatives With Temporary Wet Berth
- Table 1-3: Summary of Life Cycle Costs and Assumptions
- Table 1-4: Cost of Drydocking

The cost of drydocking is included since it was one of the criteria that were listed by TPWD which states that the dry berth solution must be more cost effective than the alternative of conducting a major dry docking every 10-15 years.

**Table 1-2: Capital Cost Summary of Alternatives with Temporary Wet Berth**

| ITEMS/ALTERNATIVES | AECOM Loaded[1] 2011 Costs w/ Temp Wet Berth | | | |
|---|---|---|---|---|
| | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 |
| 1.0 - Dredging/Removals | $1,354,000 | $4,540,000 | $6,326,000 | $3,225,000 |
| 2.0 - Dry Berth Wall | $7,207,000 | $9,949,000 | $14,555,000 | $23,105,000 |
| 3.0 - Dry Berth Slab | $6,325,000 | $6,356,000 | $6,320,000 | $7,052,000 |
| 4.0 - Dewat./Drain. Syst. | $760,000 | $738,000 | $728,000 | $768,000 |
| 5.0 - Site Improvement | $831,000 | $919,000 | $1,352,000 | $1,277,000 |
| 6.0 - Temp Wet Berth | $10,501,000 | $10,657,000 | $0 | $0 |
| 7.0 - Ship Relocation | $776,000 | $751,000 | $670,000 | $707,000 |
| 8.0 - Gen.Proj.Mob. | $1,200,000 | $1,200,000 | $1,200,000 | $1,200,000 |
| Construction Contingency @ 20% | $5,790,800 | $7,022,000 | $6,230,200 | $7,466,800 |
| Eng., Geotech Testing, CM @ 10% | $3,474,480 | $4,213,200 | $3,738,120 | $4,480,080 |
| Totals | $38,219,280 | $46,345,200 | $41,119,320 | $49,280,880 |
| Note 1: Items 1 to 8 Include General Contractor Supervision ,OH & Profit of 20% | | | | |

**Figure 1-5: Capital Cost Summary for Alternatives with Temporary Berth**

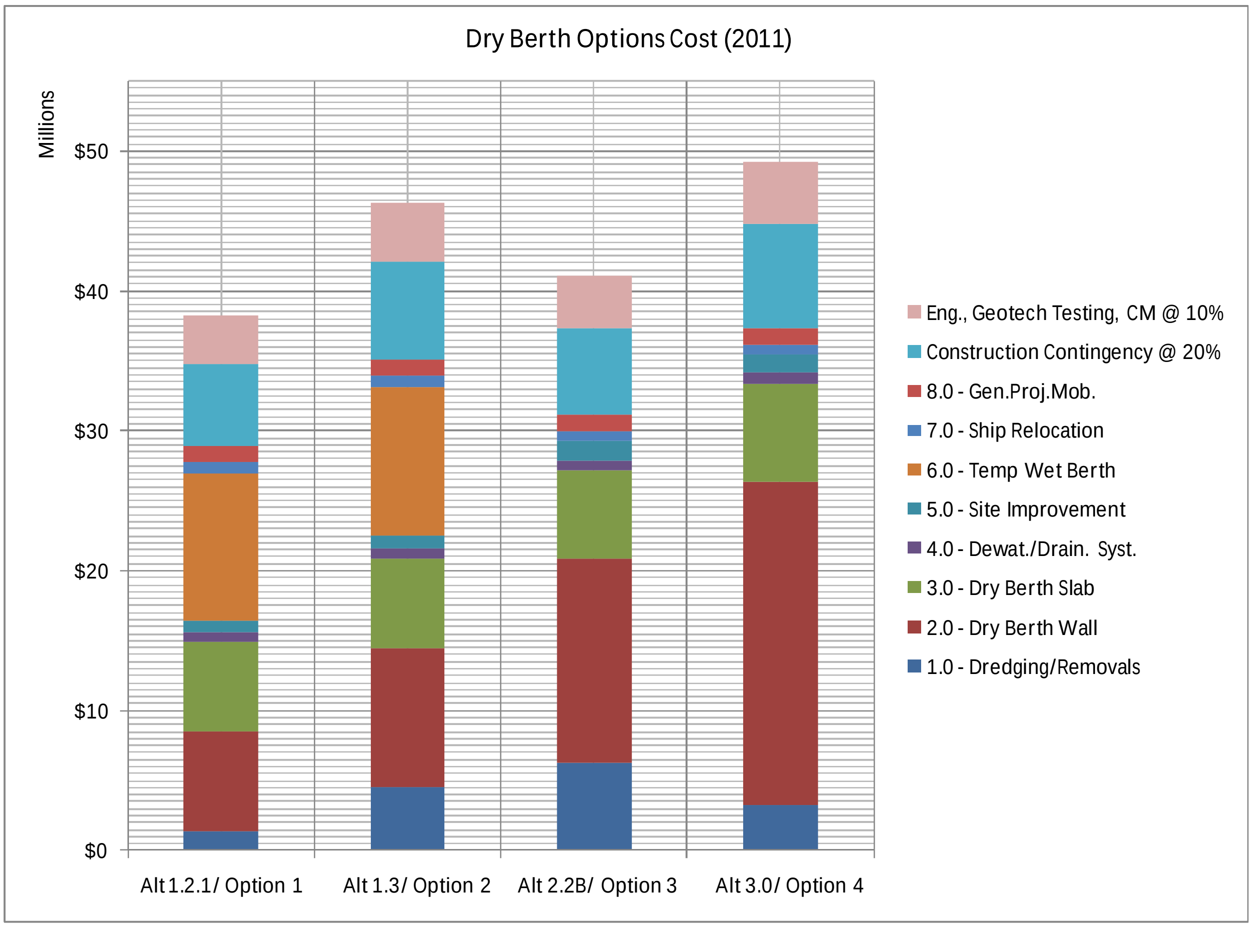


**Table 1-3: Summary of Life Cycle Costs for Alternatives**

| Life Cycle Costs Assumptions-30 Years | | | | | | |
|---|---|---|---|---|---|---|
| Item | Factor | Frequency (Yrs) | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 |
| Escalation (%) | 5% | 1 | | | | |
| Discount Rate (%) | 4% | 1 | | | | |
| Dry Berth Wall (Steel) | | | | | | |
| Capital Cost of CP(Cathodic Protection) | 6% of Wall | | | | | |
| CP Power | 6% of CP | 1 | $672,000 | $1,018,000 | $1,770,000 | $524,000 |
| CP Inspection | 3% of CP | 1 | $336,000 | $509,000 | $885,000 | $262,000 |
| Anode Replacement | 50% of CP | 15 | $381,000 | $577,000 | $1,002,000 | $296,000 |
| Periodic Structural Inspection | 1% of Wall | 5 | $399,000 | $604,000 | $1,051,000 | $311,000 |
| Maintenance Cost | 3% of Wall | 5 | $1,142,000 | $1,730,000 | $3,007,000 | $888,000 |
| Dry Berth Slab Maintenance | 0.5% | 1 | $698,000 | $702,000 | $698,000 | $779,000 |
| Drain Dewater System | 8% | 1 | $2,804,000 | $2,720,000 | $2,685,000 | $2,832,000 |
| Landscaping | 8% | 1 | $1,564,000 | $1,997,000 | $1,400,000 | $0 |
| Total Estimated Life Cycle Costs | | | $7,996,000 | $9,857,000 | $12,498,000 | $5,892,000 |

**Table 1-4: Cost of Drydocking**

| NET PRESENT VALUE OF DRYDOCKING THE TEXAS (W/O CONTINGENCIES) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 5% | | 4.0% | |
| DRYDOCKING | Year | Cost | Contin-gencies | Cost w/o Contingencies | Escalation Factor | Cost w/ Escalation | Discount Factor | NPV |
| INITIAL | 0 | $38,079,075 | 0% | $38,079,075 | 1.00 | $38,079,075 | 1.00 | $38,079,075 |
| 2ND DRYDOCKING-15 YEARS | 15 | $27,804,550 | 0% | $27,804,550 | 2.08 | $57,803,663 | 1.80 | $32,096,322 |
| 3RD DRYDOCKING-30 YEARS | 30 | $27,804,550 | 0% | $27,804,550 | 4.32 | $120,169,663 | 3.24 | $37,050,550 |
| | | | | $93,688,175 | | | | $107,225,947 |
| NET PRESENT VALUE OF DRYDOCKING THE TEXAS (W/ CONTINGENCIES) | | | | | | | | |
| | | | | | 5% | | 3.5% | |
| DRYDOCKING | Year | COST | Contin-gencies | Cost w/ Contingencies | Escalation Factor | Cost w/ Escalation | Discount Factor | NPV |
| INITIAL | 0 | $38,079,075 | 20% | $45,694,890 | 1.00 | $45,694,890 | 1.00 | $45,694,890 |
| 2ND DRYDOCKING-15 YEARS | 15 | $27,804,550 | 20% | $33,365,460 | 2.08 | $69,364,395 | 1.80 | $38,515,586 |
| 3RD DRYDOCKING-30 YEARS | 30 | $27,804,550 | 20% | $33,365,460 | 4.32 | $144,203,595 | 3.24 | $44,460,660 |
| | | | | $112,425,810 | | | | $128,671,137 |

## 1.3 COST COMPARISON OF DRY BERTH OPTIONS AND DRYDOCKING

A cost comparison of the capital and life cycle cost for the dry berth options vs. the cost of drydocking the TEXAS every 15 years without contingencies is shown in Table 1-5. Assuming that the TEXAS could be towed which is unlikely based on the hull survey inspection report, the Naval Architect stability report and the risks associated with towing, the dry berth construction is considered a superior economic option.

**Table 1-5: Comparison of Dry Berth Options and Drydocking Costs**

| Cost | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 | Drydocking (NPV) w/o Contingencies |
|---|---|---|---|---|---|
| Capital Cost | $38,219,280 | $46,345,200 | $41,119,320 | $49,280,880 | |
| Life Cycle Costs | $7,996,000 | $9,857,000 | $12,498,000 | $5,892,000 | |
| Total Costs | $46,215,280 | $56,202,200 | $53,617,320 | $55,172,880 | $107,226,000 |

## 1.4 EVALUATION AND COST OF TEMPORARY BERTH CONCEPTS

A Rough Order of Magnitude (ROM) cost estimate for the five investigated structural concepts of a temporary berth located south of the battleship existing wet berth is summarized in Table 1-6:

**Table 1-6: ROM Cost for Temporary Adjacent Berth Concepts**

| TEMPORARY BERTHING CONCEPTS FOR TEXAS | | | |
|---|---|---|---|
| Structural Concept | Type of Temporary Bulkhead | Location South of Existing Battleship TEXAS Basin | ROM Cost |
| Concept 1 | Steel Anchored | Behind Existing Bulkhead | $27,000,000 |
| Concept 2 | Cantilever | Behind Existing Bulkhead | $28,000,000 |
| Concept 3 | Soil Anchored | Behind Existing Bulkhead | $27,000,000 |
| Concept 4 | Cantilever | Waterside of Existing Bulkhead | $15,000,000 |
| Concept 5 | Soil Anchored | Waterside of Existing Bulkhead | $14,000,000 |

A summary of the findings for the four existing offsite temporary berthing locations is shown in Table 1-7:

**Table 1-7: Existing Offsite Temporary Berthing Locations**

| EXISTING TEMPORARY BERTHING LOCATIONS | |
|---|---|
| Existing Berthing Location | Findings |
| Port of Houston Turning Basin | Port of Houston was not agreeable to having the TEXAS. Would require safe entrance and exit to visiting public. |
| Barbours Cut Container Terminal | Port of Houston was not agreeable to having the TEXAS. Would require safe entrance and exit to visiting public. |
| Greens Bayou | Not Adequate Structurally |
| Bayport Cruise Terminal | Port of Houston may be agreeable to having the TEXAS. Substantial risk to tow the TEXAS . Exposed location to waves. Exposure during hurricane which could damage the TEXAS. |

## 1.5 SHIP SURVEY

The Vessel Inspection and Assessment Report by AECOM Subconsultant Ocean Technical Services (Attachment E) presents a comprehensive condition survey of the vessel as obtained from a detailed inspection carried out from November, 2010 – January, 2011. Critical problem areas have been identified as those that merit immediate consideration before the re-floating of the vessel and before the towing of the vessel to its temporary or final berthing configuration. Unless these issues are addressed satisfactorily before the vessel is re-floated or towed, there is significant risk in causing irreparable damage to the vessel. Attachment E documents the Ultrasonic Testing (UT) and corrosion analysis results from a diving survey, and the stability assessment of the vessel, respectively. The critical problem areas observed during the inspection, highlighted in Figure 1-6, are as follows:

1. Outboard Blister Tanks - The UT results showed severely wasted or holed plating throughout the length of the vessel on both Port and Starboard sides. Tugs cannot rest against the majority of the blister tank system on either side. The interior structural support members for the shell plating were either severely deteriorated or non-existent, and have separated from the armor belt above and shell plating below.
2. Hold and Inner Bottom Tanks - The lower 8 ft of inner bottom and hold are in an extremely deteriorated material condition and need to be rebuilt. Much of the interior scantlings have greater than 60 - 80% loss and are failing due to heavy weight loads (boilers, main engines, etc.). There is no transverse watertight integrity of the main bulkheads. The structural frames, bulkheads and foundations for the hold and inner bottom tanks aft of Frame No. 65 to the Stern are badly degraded. Aft of Frame No. 64 to Frame No. 135, all interior tanks contiguous to the centerline keel showed heavy to severe wastage.
3. Boiler Rooms B-3 and B-4 - The foundations for the boilers within the boiler rooms are starting to fail with signs of badly scaled or compressed plating and foundations. The floor for these boilers is completely wasted through in many areas allowing views within the underlying hold tankage with approximately additional 40 – 70 % wastage in places. The underlying support frames and longitudinals within the tankage in the hold and inner bottom are severely bent, totally wasted away or non-existent and showing ready signs of eventual collapse. The side shell on both sides appears fine with no leakage from outboard tankage, piping or manifolds.
4. Aft Trim Tanks D-12 and D-13 - This space has deteriorated throughout to a dangerous degree. The tank shell plating, longitudinal frames and keel exhibit greater than 80% loss with heavy leakage noted on the forward starboard side at the wind/waterline and to port opposite. There are badly tripped and distorted transverse frames throughout the space. The shell plating below the waterline are continuously leaking, requiring a float-type bilge pump to be engaged at all time.
5. Engine Rooms - The main engine foundations (particularly the port side unit) have failed and are a serious structural and safety concern. The six tanks under the pair of main engines are freely flooding. Of concern is the foundation in that the weight of this structure depends upon the strength of the three underlying inner bottom tank scantlings. There is very little material left within the scantlings below (engine room floor, transverse frames, longitudinal frames, keel) the main engine and a lack of support from the inner bottom tanks.
6. Chief Petty Officer (CPO) Spaces - There is severe deterioration Aft of Frame No. 120 up to the Third Deck. The tankage, trim tanks and upper deck main supports (vertical main stanchions, from shell plating/keel up to the bottom of the Second Deck), which includes the CPO spaces on Half Deck after Frame No. 115 have failed, or are soon to fail. The bulkheads, transverse web frames, floors and keel are in poor material condition and in jeopardy of failure. The vertical support

stanchions in the CPO Quarters supporting the Second Deck are severely corroded with wasted pedestal bases. The deck itself is severely wasted and unsafe in many areas. The side shell tanks are entirely wasted away. The transverse bulkheads are non-watertight and are holed. Tugs cannot rest against the stern plating on either the Port or Starboard sides, nor can they exert any pull on the stern/main-deck cleats, bollards and chocks.

7. Steering Gear, Steering Room and Overhead Void Spaces - The deck is wasted and holed with wastage greater than 60-70% over a wide area. Transverse web frames have failed entirely. The overhead sheathing, support framing, bulkheads and vertical stanchions supporting the turtleback on the overhead sheathing have failed, or are soon to fail, due to corrosion. The deck itself is poorly supported by the transverse frames and stanchions. This entire area needs to be rebuilt to withstand the movement of the ship and to impart any strength while on the keel blocks to support everything under the Third Deck.
8. Asbestos, PolyChlorinated Biphenyls (PCB), Lead Paint and Other Contaminants - While extensive asbestos remediation was completed and documented as per Texas Parks and Wildlife (TPWD), any future maintenance and/or repairs done to the ship should factor in the possibility of friable asbestos being present either at the onset of the activities or as a possible consequence. A similar assumption can be made in reference to lead paint throughout the ship. Even though the construction period and first half of the ship's life were PCB-free, since 1929, PCBs would have had the potential of occurring associated with new electrical installations. A more detailed investigation and testing regime might be necessary to determine potential PCB contamination within the ship. Any future ship repair work should include testing of potential contaminants in the area of work.

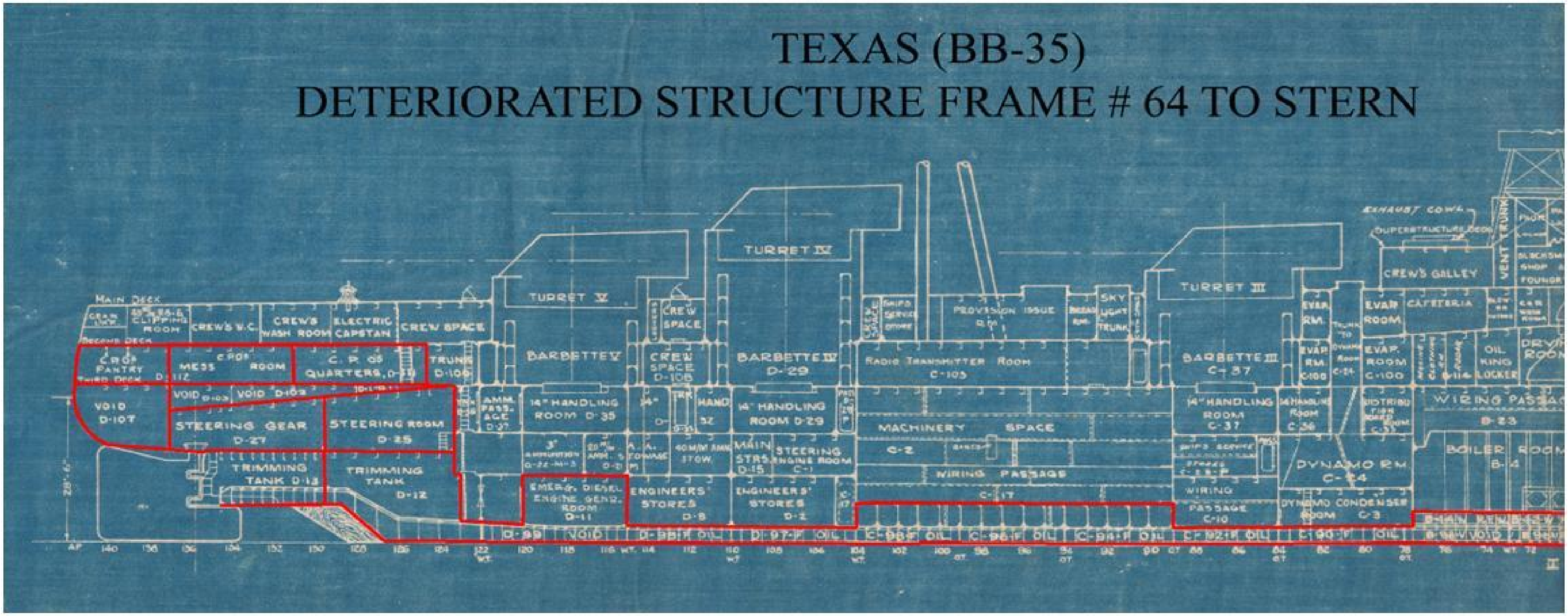
The vessel's topsides above main deck are generally in good repair. The problems associated with the vessel's exterior include poor or non-existent drainage, failed paint system, rust and scale on exposed structure and the wooden deck. This is not considered a serious problem at this juncture, and will not require repairs before the vessel is towed to its dry-berth, but will likely become a more serious issue in the future.

Based on an assessment of the stability (see Attachment E) as well as general structural condition of the ship, the following recommendations are provided with regard to any dredging (of the current slip) or towing of the ship:

- The need for monitoring of the ship will be required during any dredging at the slip or towing of the ship, due to the very poor material condition of the ship.
- In a floating condition, there is a significant danger of loss of stability for the vessel due to the possibility of up-flooding into large off-center spaces.
- The removal of blister tanks can be expected to lead to an increase in the trim and drafts of the vessel in its intact/undamaged condition due to a reduction in the waterplane area and loss of buoyancy.
- Flooding scenarios considered here indicate that large (several feet, degrees) increases in draft/trim and/or list of the vessel can occur for vessel configurations with or without blister tanks.
- Existing and supplemental pumping capability will be required onboard to keep the vessel stabilized whilst in a 'floating' condition even after temporary repairs have been completed.
- The vessel's bitts and chocks on main deck will require strengthening before the vessel can be towed.
- The underwater hull and interior scantlings need to be significantly reinforced to restore a substantial amount of structural integrity before moving the ship into the Houston Ship Channel.

- Tugs cannot be allowed to push on side plating in order to maneuver the ship
- The use of monopiles remains necessary should the vessel be moored to a temporary location as the vessel's blister tankage is not capable of supporting the side loads of the ship against fendering.

**Figure 1-6: TEXAS BB-35 Critical Areas**



## 1.6 GEOTECHNICAL

HVJ Associates, Inc. was retained by AECOM to provide a geotechnical investigation for the dry berth of the Battleship TEXAS project. The ship will be supported on deep foundations beneath the keel. The investigations will be performed in two parts. This report presents Part 1 of the investigation which is intended to provide the information needed to support preliminary design and cost estimates for the evaluation of the dry berth alternatives. Part 2 is intended to provide additional investigation needed to support detailed design of the selected alternative, and will be provided later.

The subsurface stratigraphy at the project site was determined by drilling and sampling one 300-foot boring and two 120-foot borings on land; and three 150-foot borings in water. The subsurface soils generally is comprised of very soft to hard fat clays, sandy lean clays and lean clays to the termination depth of the borings. Loose to very dense sand layers generally about 5 feet thick were encountered at variable elevations in the borings. Two piezometers were installed to monitor groundwater elevation behind the slope which ranged between +0.74 feet and +1.47 feet. Details of the field and laboratory investigation are presented in the Part 1 Geotechnical Data Report submitted separately.

Four alternative designs were developed for the Part 1 study. HVJ would like to point out that for several of the berth layouts a substantial portion of the footprint is outside of the area explored by borings for the Part 1 study. These analyses should be considered preliminary until a boring program that fully encompasses the facilities for the selected alternative is performed in Part 2. Based on the engineering analyses performed for this study, the findings and recommendations for each Alternative are summarized below:

### 1.6.1 SHIP FOUNDATION

The ship keel blocks for all four alternatives may be designed based on drilled shaft or driven pile foundations as shown in Table 1-8:

**Table 1-8: Keel Block Foundations**

| Keel Block Foundations | | |
|---|---|---|
| 36" Diameter Drilled Shaft | | |
| Number of Drilled Shafts | Shaft Length Below Bottom of Slab | Allowable Axial Capacity (FS = 2) |
| | Feet | Tons |
| 128 | 90 | 200 |
| 78 | 105 | 250 |
| 34 | 120 | 300 |

### 1.6.2 GEOTECHNICAL RESULTS

The geotechnical results for the various parameters of the design are summarized in Table 1-9:

**Table 1-9: Geotechnical Design**

| | | | | | |
|---|---|---|---|---|---|
| Design Parameter | Alternate | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 |
| | Dike/Top of King Pile Elv. | +13' | +13' | +13' | +13' |
| | Dry Berth Bottom Elv. | -26' | -38' | -38' | -38' |
| slope Stability | Slope | 3H:1V | 4H:1V | 4H:1V | NA |
| | Short Term | 1.751 | 1.778 | 1.778 | NA |
| | Drawdown[1] | 1.25 | 1.25 | 1.25 | NA |
| | Long Term | 1.611 | 1.509 | 1.509 | NA |
| King Pile | Max Moment (ft-kip/ft) | 1,067 | 1,267 | 1,183 | 2,133 |
| | Max Moment of Inertia ($in^4$/ft) | 11,000 | 11,000 | 11,000 | 16,000 |
| | Max Deflection[2] (in) | 8.9 | 12.4 | 9.8 | 19.4 |
| | Max Length (ft) | 110 | 110 | | 125 |
| Slurry Wall | Max Moment (ft-kip/ft) | | | | 116.7 |
| | Moment of Inertia ($in^4$/ft) | | | | 9,444 |
| | Max Deflection (in) | | | | 1.1 |
| | Length (ft) | | | | 80 |
| Seepage | Gallons/day /ft of Slope | 20 | 20 | 20 | NA |

Note: 1. The drawdown analysis shows that dewatering the berth over a period of at least 14 days will maintain the required factor of safety during drawdown.

Note 2: Maximum deflection for 100-year Design Condition

# 2 CONDUCT STUDIES/SURVEYS

## 2.1 TOPOGRAPHIC SURVEYS

Topographic surveys were performed as an extension of the existing mooring facility where the Battle-ship is currently located. Data was field collected landward at limits extending a minimum of 300ft northeasterly and southeasterly, and 1000ft southwesterly of the existing mooring facility. Additional data will be collected from the water's edge to overlap with the bathymetry for the creation of a single seamless digital terrain model (DTM).

Topographic information collected included the following:

- Elevations across the property and apparent grade breaks were noted. Elevations were taken on the top of curbs or edge of paving.

- The locations of existing utility lines on the surveyed site were shown to the extent possible. Including, visible utilities, water valves, hydrants, storm drains, manholes, curbs, sidewalks, trees (6" and larger), signs, etc, depth information will be obtained in manholes and inlets and pipe size and direction of pipes will be determined to the extent possible. For private utilities (CenterPoint, AT&T, Time Warner Cable), requests were submitted for information to the utility companies. We will also contact a locating service (Texas811 is a one-call notification center for Texas) to see if the underground utilities can be marked on the ground. If this is possible, we will locate the utility marks and show their locations on the survey.

This effort included using Global Positioning System (GPS) equipment and methodology to recover and verify existing horizontal and vertical control in the area. All vertical control used were referenced to the North American Vertical Datum of 1988 (NAVD 88), Mean Low Tide (MLT). All horizontal controls were referenced to the Texas State Coordinate System, South Central Zone, North American Datum (NAD) 1983.

The field data obtained was developed to produce a single overall plan view drawing and digital terrain model (DTM) and was generated electronically in AutoCAD® format.

See attached topo and bathy survey drawings in Attachment A.

## 2.2 BATHYMETRIC SURVEYS

Bathymetric surveys were performed as an extension of the existing mooring facility where the Battle-ship is currently located. AECOM performed a single beam hydrographic surveys of the area immediately southwesterly of its current location where the Battleship may be relocated (including sections across the Houston Ship Channel) using Differential GPS positioning – including associated data processing.

The data was incorporated into the topographic survey file to develop a single overall plan view drawing and digital terrain model (DTM) with contours and was developed electronically in AutoCAD® formats.

See attached topo and bathy drawings in Attachment A.

## 2.3 GEOTECHNICAL INVESTIGATIONS

A geotechnical investigation was performed by HVJ Associates for the Phase 1 Conceptual Design. The purpose of the geotechnical investigation was to evaluate the subsurface conditions and establish geotechnical engineering design parameters for the conceptual structural design and cost estimate needed for each alternative. The findings of the geotechnical investigation are summarized in a Part 1 geotechnical report, which is included as Attachment B to the Conceptual Design Report.

The Part 1 geotechnical report is in two segments:

- Geotechnical Data Report
- Geotechnical Design Report

### 2.3.1 FIELD INVESTIGATIONS

The subsurface stratigraphy at the project site was determined by drilling and sampling:

- One 300-foot boring and two 120-foot borings on land
- Three 150-foot borings in water

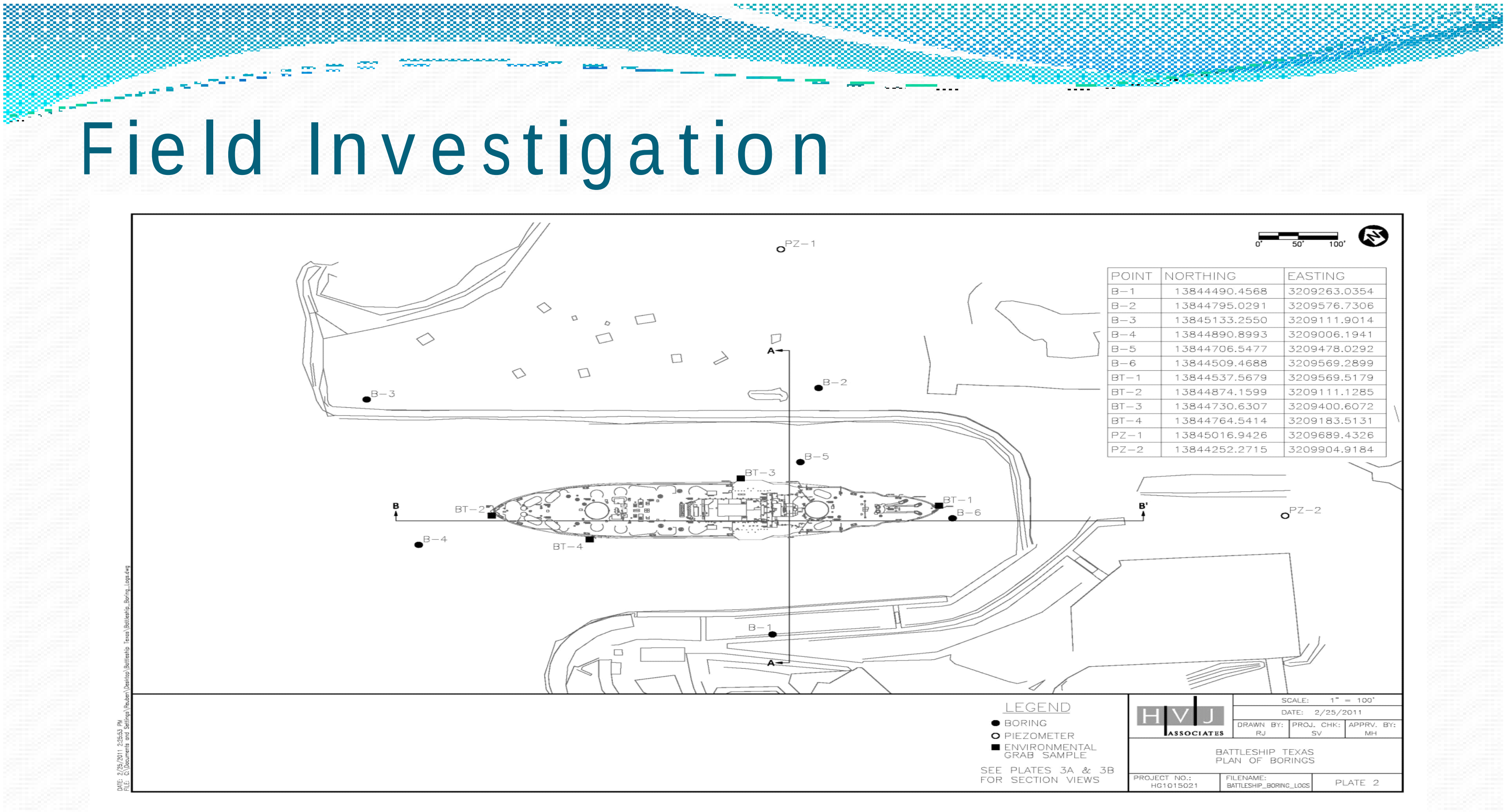
The land borings were drilled using an all terrain mounted drilling equipment using dry and wet auger techniques. The water borings were drilled using a jack up barge. The borings were drilled at the locations indicated on the plan of borings, Attachment B-1, Plate 2. The boring logs and a key to the soil classification and symbols are included in Attachment B-1, Appendix A.

Boring coordinates and elevations are shown in the following table:

**Table 2-1: Boring Coordinates and Elevations**

| Boring No. | Northing (ft.) | Easting (ft.) | Local Coordinates Northing (ft.) | Local Coordinates Easting (ft.) | Ground Surface Elevation (ft.) | Drilling Depth (ft) |
|---|---|---|---|---|---|---|
| B-1 | 13844490.45 | 3209263.03 | -399.24 | -271.9 | 11.94 | 120 |
| B-2 | 13844795.02 | 3209576.73 | 33.96 | -212.68 | 4.34 | 120 |
| B-3 | 13845133.25 | 3209111.9 | 13.7 | -787.18 | 5.08 | 300 |
| B-4 | 13844890.89 | 3209006.19 | -242.29 | -720.99 | -21.5 | 150 |
| B-5 | 13844706.54 | 3209478.02 | -96.55 | -235.84 | -13.45 | 150 |
| B-6 | 13844509.46 | 3209569.28 | -195.46 | -12.49 | -16.51 | 150 |

**Figure 2-1: Geotechnical Field Investigation**




| POINT | NORTHING | EASTING |
|---|---|---|
| B-1 | 13844490.4568 | 3209263.0354 |
| B-2 | 13844795.0291 | 3209576.7306 |
| B-3 | 13845133.2550 | 3209111.9014 |
| B-4 | 13844890.8993 | 3209006.1941 |
| B-5 | 13844706.5477 | 3209478.0292 |
| B-6 | 13844509.4688 | 3209569.2899 |
| BT-1 | 13844537.5679 | 3209569.5179 |
| BT-2 | 13844874.1599 | 3209111.1285 |
| BT-3 | 13844730.6307 | 3209400.6072 |
| BT-4 | 13844764.5414 | 3209183.5131 |
| PZ-1 | 13845016.9426 | 3209689.4326 |
| PZ-2 | 13844252.2715 | 3209904.9184 |

### 2.3.2 LAB TESTING

Selected soil samples were tested in the laboratory to estimate physical and engineering properties applicable to the site. All tests were performed according to the relevant ASTM Standards. These tests consisted of moisture content measurements, Atterberg limits, hand penetrometer, percent finer than No. 200 sieve, unconsolidated undrained (UU) compression, unconfined (UC) compression, consolidated undrained (CU) compression, consolidation and unit dry weight tests.

The Atterberg limits and percent passing No. 200 sieve tests were utilized to verify field classification by the Unified Soils Classification System. The compression tests were performed to obtain the shear strength parameters of the soil. The consolidated undrained (CU) test was performed to obtain the drained shear strength of the soil. Consolidation test was performed to estimate the foundation settlement.

The type and number of tests performed for this investigation are summarized below:

Summary of Laboratory Tests

| Type of Test | Number of Tests |
|---|---|
| Moisture Contents (ASTM D2216) | 192 |
| Atterberg Limits (ASTM D4318) | 58 |
| Percent Passing No. 200 Sieve (ASTM D1140) | 51 |
| Pocket Penetrometer | 171 |
| UC- Compression (ASTM D 2166) | 9 |
| UU- Compression (ASTM D 2850) | 61 |
| CU- Compression (ASTM D 4767) | 7 |
| Unit Dry Weight (ASTM D 2166) | 70 |
| Consolidation (ASTM D 2435) | 6 |

The laboratory test results are presented in Attachment B-1:

- Boring logs are presented in Attachment A/Appendix A.
- The consolidated undrained compression test results are presented in Attachment A/Appendix B.
- The consolidated undrained compression test results are presented in Attachment A/Appendix G and the consolidation test results are presented in Attachment A/Appendix H.

### 2.3.3 SITE CHARACTERIZATION

The subsurface soils generally comprise of very soft to hard fat clays, sandy lean clays and lean clays to the termination depth of the borings. Subsurface profiles showing conditions at the site are shown in Plates 3A and 3B. Loose to very dense cohesionless clayey sands, silty sands, sandy silts and silts were encountered between elevations -6 feet and -11 feet in boring B-1; between elevations -4 feet and -9 feet, and between elevations -69 feet and -74 feet in boring B-2; between elevations -212 feet and -238 feet, and below elevation -283 feet in boring B-3; between elevations -64 feet and -74 feet, between elevations -84.5 feet to -89.5 feet and between elevations -134.5 feet and -139.5 feet in boring B-4. Fill material comprising of fat clay and sandy lean clay with shells and rocks was encountered between elevations +11 feet and -1 feet at boring locations B-1 and B-3. Ferrous and calcareous nodules were encountered at various depths in all the borings.

Groundwater was encountered at elevations ranging between -4 feet and 0 feet during the drilling operations. Two 40-foot piezometers were installed to monitor groundwater elevation behind the slope. Water level readings in the piezometers ranged between +0.74 feet and +1.47 feet.

## 2.3.4 SOIL STRUCTURE INTERACTION

### *2.3.4.1 SLOPE STABILITY*

Stability analyses were conducted By HVJ using the SLOPE/W 2007 slope stability program developed by GEO-SLOPE International Ltd. that calculates the factor of safety against slope failure.

Slope stability analyses were performed for the End of Construction Case, Rapid Drawdown Case and Long Term Case. The following are the minimum required factors of safety for the different loading conditions that are expected during the lifetime of the project.

**Table 2-2: Minimum Required Factors of Safety**

| Loading Condition | Required Minimum Factor of Safety |
|---|---|
| End of Construction | 1.30 |
| Drawdown[1] | 1.25 |
| Long-Term[2] | 1.50 |

1: The drawdown case models the condition where dewatering of the berth creates a large unbalanced piezometric head in the bank slope.
2: The long-term design case represents steady state piezometric and stress conditions.

The results of the stability analysis for the various Alternatives are shown in the following table:

**Table 2-3: Slope Stability Analysis**

| Alternate | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 |
|---|---|---|---|---|
| Dry Berth Bottom Elv. | -26 | -38 | -38 | -38 |
| Slope | 3H:1V | 4H:1V | 4H:1V | NA |
| Short Term | 1.751 | 1.778 | 1.778 | NA |
| Drawdown[1] | 1.25 | 1.25 | 1.25 | NA |
| Long Term | 1.611 | 1.509 | 1.509 | NA |

Note: 1. The drawdown analysis shows that dewatering the berth over a period of at least 14 days will maintain the required factor of safety during drawdown.

### *2.3.4.2 SEEPAGE*

HVJ performed a seepage analysis for the various alternatives using SEEP/W 2007 developed by GEO-SLOPE International Ltd. This is a finite element software product for analyzing groundwater seepage and excess pore-water pressure dissipation problems within porous materials such as soil and rock. The hydraulic conductivity for the seepage analysis was determined based on the results of in situ slug tests in piezometers installed during the Part 1 field investigation; the results of those tests are presented in the geotechnical data report.

Seepage analyses were performed for many cross sections for the various alternatives. The results were similar. For the sloped sections of the berth the estimated seepage rate is 20 gallons per day per linear foot of slope. For the wall sections, the seepage through the soil around the wall was negligible, and any seepage that does occur will be determined by the amount of water that penetrates the wall structure.

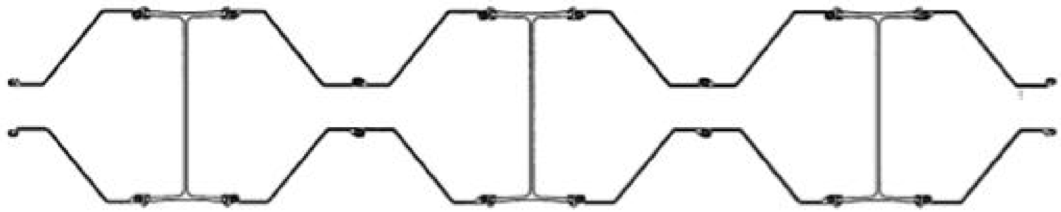
#### 2.3.4.3 CELLULAR COFFERDAMS STRUCTURES

Cellular cofferdam structures which are made of flat sheet pile sections were initially considered for the closure and retaining walls, were evaluated and judged to be less economically viable than the king pile structures which were adopted for the conceptual design Alternatives. Issues related to the cellular cofferdam included replacement of soft material inside the cofferdam with suitable fill that would have to be imported and settlement and bearing capacity requirement that made the cofferdam increase in diameter and depth in order to have acceptable factors of safety.

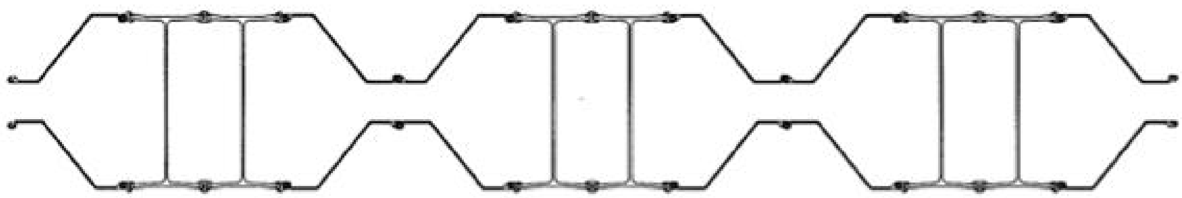
#### 2.3.4.4 CANTILEVER KING PILE STRUCTURES

A king pile retaining wall is a modification of a sheet pile retaining wall system in which structural steel sections such as H piles or circular steel piles are alternated with sheet pile sections. The benefit is an increase in the moment capacity and a decrease in horizontal deflection compared to sheet piles alone. For the dry berth design, use of king piles makes the option of a cantilever retaining wall feasible in locations that would otherwise require a composite system such as a cellular cofferdam.

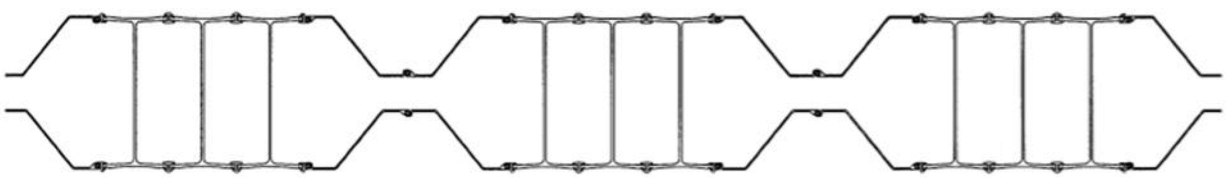
Analyses for the king pile walls were performed using non linear soil structure interaction generalized beam-column model and analyses the behavior of a flexible retaining wall with or without deadman or tieback support. A summary of the results of the analysis is shown in Table 2-4.



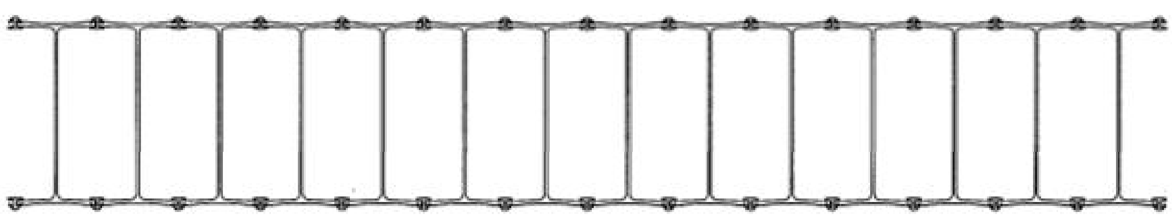
King Pile Wall Type 1



King Pile Wall Type 2



King Pile Wall Type 3



King pile Wall Type 4

Table 2-4: Analysis Results Summary

| Alt | Section[1] | Wall Height, Feet | Length Feet | I(in$^4$/ft) | Max. Deflection | | Max. Moment | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Inches | Depth, ft | ft-kip | Depth, ft |
| Alternative 1.2.1/ Option 1 | B w/deadman (& A) | 33 | 65 | 2,414 | 0.8 | 18 | 129 | 21 |
| | C (& D) | 43 | 110 | 11,000 | 10.8 | 0 | 1200 | 55 |
| | E (& E') | 23 | 70 | 3,448 | 5.7 | 0 | 393 | 34 |
| | F | 33 | 110 | 3,448 | 8.9 | 0 | 489 | 44 |
| | G (& F') | 35 | 110 | 11,000 | 6.7 | 0 | 892 | 49 |
| Alternative 1.3/ Option 2 | A w/deadman (& B) | 45 | 80 | 241 | 2.1 | 25 | 262 | 25 |
| | C (& D, D') | 46 | 110 | 11,000 | 12.4 | 0 | 1267 | 58 |
| | E' (& E) | 38 | 110 | 11,000 | 8.4 | 0 | 1033 | 51 |
| | F | 33 | 75 | 11,000 | 1.5 | 0 | 261 | 46 |
| | G | 43 | 110 | 11,000 | 11.6 | 0 | 1267 | 54 |
| Alternative 2.2B/ Option 3 | B (& A, C) | 33 | 110 | 11,000 | 5.16 | 0 | 738 | 47 |
| | D | 16 | 65 | 11,000 | 0.59 | 0 | 172 | 27 |
| | E | 14 | 55 | 1,724 | 0.41 | 0 | 29 | 26 |
| | F | 35 | 110 | 16,000 | 7.2 | 0 | 1192 | 55 |
| | F | 35 | 110 | 11,000 | 9.8 | 0 | 1183 | 55 |
| Alternative 3.0/ Option 4 | A (& B,C) | 26 | 65 | 2,414 | 4.5 | 0 | 255 | 36 |
| | D (& D') | 35 | 80 | 6,897 | 4.5 | 0 | 463 | 46 |
| | E | 51 | 125 | 16,000 | 19.4 | 0 | 2133 | 56 |
| | Slurry Wall[2] (water @ +3) | 52 | 80 | 9,444 | 0.87 | 33 | 100 | 60 |
| | Slurry Wall[2] (water @ +13) | 52 | 80 | 9,444 | 1.07 | 33 | 117 | 60 |

Notes:
1. Locations of Sections are shown in Attachment C
2. The Slurry Wall analysis includes lateral supports at a depth of 10, 25, and 38 feet.

### *2.3.4.5 SLURRY WALLS/DIAPHRAGM WALLS*

A slurry wall is a technique used to build reinforced-concrete walls by excavating a trench to create a form for wall construction. The trench is kept full of bentonite slurry at all times in order prevent the trench from collapsing by providing outward pressure which balances the inward hydraulic forces and prevents water flow into the trench. A reinforcement cage is then lowered into the trench which is then filled with tremie concrete, which displaces the slurry. On completion of concreting, digging within the now concrete wall-enclosed area can proceed. To prevent the concrete wall from collapsing into the newly open area, tieback supports are installed. The wall construction involves the following sequence:

- Stage 1: Fixing of Alignment
- Stage-2: Guide wall Construction
- Stage-3: Trenching
- Stage-4: Trench Cleaning
- Stage-5: Stop ends fixing
- Stage-6: Reinforcement Cage lowering
- Stage-7: Placing of Concrete
- Stage-8: Withdrawal of Stop ends

Depending on the height of the wall a multi-level tie back system is used in order limit moments and deflection of the wall. Moments and deflections in the slurry wall for a three-level tie rod system are shown in Table 2-4.

#### 2.3.4.6 WET BERTH STRUCTURES

For the conceptual design the wet berth structure was assumed to be made of cantilevered and anchored sheet pile bulkhead segments.

#### 2.3.4.7 DRY BERTH PILING

Capacity analysis was performed by HVJ for drilled shaft foundations. Drilling will require the use of drilling mud for shaft construction. HVJ performed analysis for 24" square concrete piles and 36" diameter drilled shafts. And the design team opted for the use of drilled shafts which is a very common method of construction in the Houston area with many contractors familiar with this method of construction.

For the conceptual design the same type and number of shafts was adopted.

A summary of the dry berth foundation is shown in the following table:

**Table 2-5: Keel Block Foundations**

| Keel Block Foundations | | |
|---|---|---|
| 36" Diameter Drilled Shaft | | |
| Number of Drilled Shafts | Shaft Length Below Bottom of Slab | Allowable Axial Capacity (FS = 2) |
| | Feet | Tons |
| 128 | 90 | 200 |
| 78 | 105 | 250 |
| 34 | 120 | 300 |

#### 2.3.4.8 DIKES

The proposed dikes would be to the same elevation as existing ones.

#### 2.3.4.9 EXISTING SOUTH SHEET PILE WALL

The existing south sheet pile was saved by maintaining the required slope for safe stability considerations for both dry berth Options 1 & 2. See Figure 2-2.

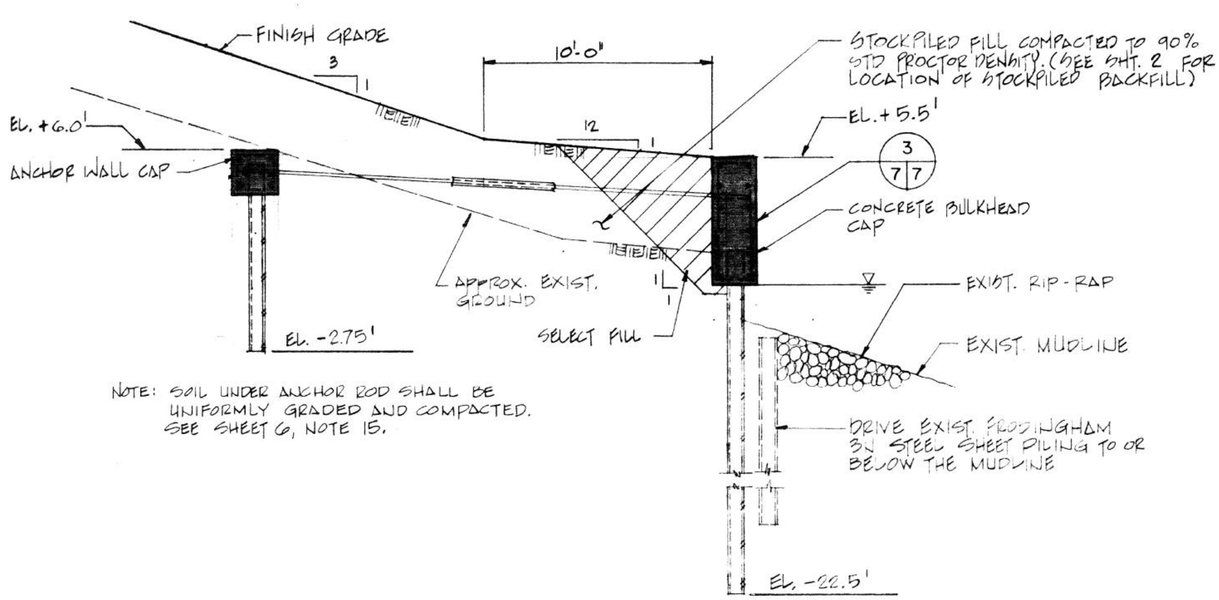



**Figure 2-2: Existing Sheet Pile**

## 2.4 NATURAL RESOURCES STUDIES

During Phase I of the Battleship TEXAS Permanent Dry Berth Project, the team conducted preliminary field surveys and literature reviews to develop a description of the existing environment surrounding the current mooring location of the Battleship TEXAS. The surveys were conducted to identify environmental constraints associated with three alternative sites identified at San Jacinto State Park (SJSP) for a permanent dry berth for the Battleship TEXAS. This information was used to assist the design team in evaluating potential dry berth options. Preliminary field surveys and literature reviews were conducted during the spring and summer of 2011. Maps depicting the locations of Alternatives B, C, and D are included in Attachment C, Appendix A.

Resources evaluated during this investigation included: waters of the United States (U.S.), including wetlands (herein referred to as waters and wetlands); threatened and endangered species; vegetation; soil; water resources; essential fish habitat (EFH); and coastal zone management constraints. Investigations related to air quality, noise, and environmental hazards (hazardous materials/waste) were not performed during the Phase I investigations, but would be performed early in Phase II as alternative sites are more fully defined and the National Environmental Policy Act compliance study is initiated.

## 2.5 CULTURAL RESOURCE STUDIES

In preparation for the production of the design alternatives developed during Phase 1 of the dry berthing of the Battleship TEXAS, the AECOM team was required to document the relevant cultural resources within the project area. The documentation effort involved assessing the potential for the dry berthing project to impact the project area's significant cultural resources, particularly those associated with the 1836 Battle of San Jacinto. Cultural resources identified during this process include both archeological sites and historic resources. Although this effort did not include undertaking any archeological surveys or clearing, it did recognize the significant historic resources that make up the battleground and the ship itself. In addition, as part of the cultural resources analysis process, the AECOM team relied on previous experience at the San Jacinto Battleground State Historic Site, particularly the work undertaken for the 2005 *San Jacinto Battleground State Historic Site Cultural Landscape Report (CLR)*, and also the collective expertise and knowledge of the site and ship management staff.

The AECOM team produced the *Cultural Resources Constraints Analysis for the Dry Berthing of the Battleship* Texas*, San Jacinto Battleground State Historic Site, Harris County, Texas* (January 7, 2011) in order to understand the regulatory framework for the project and to provide a background review of the cultural resources literature for the project area. These two goals for the *Cultural Resources Constraints Analysis* aided the design team in understanding the historic and cultural resources that are sensitive to change throughout the dry berthing project.

The project area is defined as the area of potential effect (APE). The *Cultural Resources Constraints Analysis* defined the APE as the berth for the ship, a corridor around the berth, and a corridor around the shoreline to the south of the berth. The Phase I APE (see Figure 1, Attachment D) is contained within the San Jacinto Battleground State Historic Site and encompasses approximately nine acres. Phase 1 design alternatives propose intensive modifications within the APE in the vicinity immediately surrounding the current ship berth. Cultural resources within the APE that may be affected by the proposed design alternatives are subject to the regulations set forth in Section 106 of the National Historic Preservation Act of 1966 (NHPA) and the Antiquities Code of Texas.

The battleground has been the subject of substantial archeological investigations over time. These investigations have identified archeological resources associated with the battle itself, the historic San Jacinto Inn (1926-1927), and prehistoric use of the site among others. However, substantial dredging, fill, and subsidence likely have obscured the archeological record somewhat. Previous archeological reports indicated that the archeological record at the San Jacinto Battleground had been destroyed by collectors, dredging, and park modifications, but other investigations have suggested otherwise, as shown by the more recent recovery of artifacts from the 1836 battle.

The *Cultural Resources Constraints Analysis* concluded that construction activities associated with the proposed dry berthing of the ship have the potential to impact cultural resources within the APE, including below-grade battlefield surfaces, previously unidentified prehistoric sites beneath existing levees and dredge fill, and graves associated with the paupers' cemetery probably located within the original 10-acre park tract.

Additional cultural resource investigations undertaken in advance of Phase 2 compliance efforts may propose expanding the APE to include both cultural resources and visual resources. This expanded APE would include a larger portion of the park, as well as land across the Houston Ship Channel. Recognized cultural resources within the larger park boundary and expanded APE include the battleground itself, which is a National Historic Landmark (NHL); the San Jacinto Monument, which is an American Society of Civil Engineers State and National Historic Structure; and the Battleship *TEXAS*, which is a National Historic Landmark, a Texas State Archeological Landmark, and a National Mechanical Engineering Landmark. The San Jacinto Battleground NHL contains contributing resources (identified in the 2005 *San Jacinto Battleground State Historic Site Cultural Landscape Report*) such as the 1836 Texan encampment location, segments of the Harrisburg-Lynchburg Road, prairie, islands of trees, marsh, and topographic conditions such as depressions and ridges that influenced the events of the 1836 battle. The staff at the San Jacinto Battleground State Historic Site has been undertaking prairie restoration at the battleground in the years since the 2005 CLR was undertaken in an effort to restore the integrity of areas within the overall battleground.

At the time of the battleground's nomination as an NHL, the commemorative landscape and associated features—as well as the Battleship *TEXAS*—were specifically excluded from the national significance of the battleground landscape. Phase 2 studies will examine the possibility of expanding the historic context of the NHL to include the commemorative landscape constructed in the late 1930s to memorialize the battle at its centennial. Features associated with this memorial context are the monument, the reflecting pool, the designed roads, and the markers scattered throughout the park, among others. In addition, the ship's berth at the park was constructed in 1948 and Battleship *TEXAS* has remained there almost continuously since that time with the exception of a 1988 repair in dry dock. Thus the ship has been present at the park for well over 50 years and may have some significance as a result. Coordination with SHPO will be required to determine if this additional historic significance and associated contributing features should be recognized during the design and compliance process.

#### 2.5.1.1 ARCHEOLOGICAL

On behalf of the Texas Parks and Wildlife Department (TPWD) c/o AECOM, SWCA Environmental Consultants conducted a cultural resources constraints analysis for the proposed dry berthing of the Battleship TEXAS, National Historic Landmark. The Battleship TEXAS which was known as the USS TEXAS, BB35 and archaeological site number 41HR744. The proposed project is situated within the San Jacinto Battleground State Historic Site (41HR277) in southeast Harris County. The purpose of this constraints analysis is to gather available information on previously recorded archaeological surveys, archaeological sites, and historic resources within the project area and to assess the potential for the undertaking to impact significant cultural resources. The goal is to provide information for project planning and development, as well as estimates on possible future work that may be required for regulatory compliance.

The SWCA report documents the results of the cultural resources background review and an assessment of possible historic property and archaeological site locations. An archaeological survey of the project area was not conducted as an element of this research. This constraints analysis does not constitute any form of archaeological clearance for the project area, but may be used to coordinate future cultural resource compliance with state and/or federal agencies.

The area of potential effect (APE) for the proposed project includes the berth for the Battleship TEXAS, a corridor surrounding the berth, and a corridor along the shoreline to the south of the berth (Figure 1). The project area is contained within the San Jacinto Battleground State Historic Site (41HR277) and it is located on the Highlands, Texas USGS 7.5-minute topographic quadrangle map. The proposed project encompasses approximately 9 acres.

The Battleship TEXAS was originally parked in its berth at the San Jacinto Battleground in 1948. Major repairs to the ship and modifications of the berthing area were conducted in 1988 through 1990. The current project involves one of four proposed designs for the dry berthing of the ship at the site. Each of these plans would involve extensive modifications of the berthing area. The primary public access point for the ship would be relocated to the north side of the berth – the opposite of the current arrangement. All of the existing buildings located on the south (the battleground side) of the berth would be demolished (TPWD 2008). SWCA constraints analysis report entitled "Cultural Resources constraints analysis for the dry berthing of the Battleship TEXAS, San Jacinto battleground State historic site, Harris County, Texas" is shown in Attachment D.

## 2.6 OTHER STUDIES

### 2.6.1 SHIP CHARACTERISTICS

**Table 2-6: BB-35 Characteristics**

| Vessel Parameter | Dimensions |
|---|---|
| Length Overall | 573 ft |
| Length WL Normal Designed | 565 ft |
| Length WL Actual | 565 ft, 7 1/4 in |
| Length Between Perpendiculars | 565 ft, 6 1/16 in |
| Extension Beyond Forward Perpendicular | 8 ft, 3/4 in |
| Extension Beyond Aft Perpendicular | 0 |
| Breadth (Extreme to Outside of Armor) | 106 ft, 3/4 in |
| Frame Spacing | 4 ft (Centers) |
| Number of Frames Between Perpendiculars | 141 |
| Draft (Forward) | 22 ft, 10 in * |
| Draft (Aft) | 26 ft, 1 in * |
| Displacement (Light Ship Condition) | 25,119 Long Tons |
| Bottom of Keel to Molded Base Line | 1 ft, 5/8 in |
| Draft to Designer's Water Line | 28 ft, 6 in |
| Tons Per Inch Immersion | 91.7 Long Tons |
| Wetted Surface to Normal LWL | 65,700 Sq Ft |
| Ratio of Length to Beam | 5.934 |

* Drafts obtained from Ship Hull Characteristics Program (SHCP) computations performed by Jerry Posshel for Intact Stability.

Note : As per TPWD, since 3/1/2005, Forward and Aft Drafts have consistently been observed to be 22 ft, 9 in and 27 ft, respectively.

### 2.6.2 DESIGN WATER LEVELS

FEMA (Federal Emergency Management Association) Floodplain zone levels and associated water levels for the San Jacinto area are as follows:

**Table 2-7: Flood Storm Elevations at San Jacinto**

| FEMA Floodplain/Storm Surge Levels | Ref MLT-FT |
|---|---|
| 0.2% (Rp=500 Yrs) | 16.45 |
| 1% (Rp=100 Yrs) | 13.04 |
| 2% (Rp=50Yrs) | 11.45 |
| 10% (Rp=10Yrs) | 6.74 |
| Mean Higher High Water (MHHW) | 2.74 |
| Mean High Water (MHW) | 2.64 |
| Mean Tide Level (MTL) | 2.04 |
| Mean Sea Level (MSL) | 2.07 |
| Mean Low Water (MLW) | 1.44 |
| Mean Lower Low Water (MLLW) | 1.24 |
| COE Mean Low Tide (COE MLT) | 0.00 |

One of the critical items for the design is the elevation of the cofferdams and dikes around the dry berth. The current design assumption is for an elevation of + 13.0 ft (MLT; Mean Low Tide – standard datum used on this project) for all protective/enclosure cofferdam/revetment/dike structures.

The +13.0 ft (MLT) elevation was based on a 100-year return period water level, selected in accordance with guidance from ASCE 24-05. This corresponds to an annual probability of exceedance of 1 %, i.e., in any given year there would be a 1 % chance of the water level at the site exceeding +13.0ft (MLT). At this level of recurrence, there would be a 39% cumulative risk of exceeding the selected flood level one or more times over an assumed 50 year facility design life.

In selecting the +13.0 ft MLT elevation, we have assumed the facility would be classified as a Category I structure per Table 1-1 of ASCE 24, since there is no hazard to human life in the event of flooding. If TPWD desires to classify the structure at a higher importance category out of consideration of potential damage to the ship or due to the costs associated with restoring the facility after flooding, it may be appropriate to set our elevation at least one foot above flood plain, in accordance with Table 2-1 of ASCE 24. It would also be appropriate to increase the elevations as needed to provide an allowance for anticipated settlement due to cofferdam and dike weight.

We have calculated some additional risk/exceedance probabilities for various combinations of design life and return period, which are shown in the table below. It is worthwhile noting that any increase in the elevation above +13.0 ft MLT would have an impact not only the height, but also the size of the cofferdam cells and the plan dimensions of the revetments.

**Table 2-8: Additional Risk/Exceedance Probabilities for Various Combinations of Design Life and Return Period**

| Design Working Life of Facility (Years) | Event Return Period (Years) | FEMA (2007) Water Level (ft, NAVD88)* | FEMA (2007) Water Level (ft, MLT)+ | Cumulative Risk of Exceedance # (%) |
|---|---|---|---|---|
| 50 | 50 | 10.0 | 11.5 | 64% |
| | 100 | 11.5 | 13.0 | 39% |
| | 500 | 15.0 | 16.5 | 10% |
| 100 | 100 | 11.5 | 13.0 | 63% |
| | 500 | 15.0 | 16.5 | 18% |
| 500 | 500 | 15.0 | 16.5 | 63% |
| <u>Notes</u> | | | | |
| [*] | These water level values are estimated (average for general project vicinity) based on FEMA (2007) "Flood Insurance Study, Harris County, TX and Incorporated Areas", Volume 1 of 8, Flood Insurance Study No. 48201CV001A, Revised, June 18, 2007 | | | |
| [+] | Elevation (MLT, ft) = Elevation (NAVD88, ft) + 1.44 ft, and rounded UP to single decimal | | | |
| [#] | The cumulative risk of exceedance is the risk of exceeding the selected flood level one or more times over the facility's design working life. | | | |

Locations (as per FEMA (2007) study) used for calculating "average" FEMA water levels in the table above are as listed below:

G100-00-00 (BUFFALO BAYOU, HOUSTON SHIP CHANNEL)
- At confluence of San Jacinto River (G100-00-00)
- At confluence of Boggy Bayou (G105-00-00)
- Approximately 0.8 mile downstream of confluence of Greens Bayou (P100-00-00)
- At confluence of Hunting Bayou (H100-00-00)
- At confluence of Vince Bayou (I100-00-00)
- At confluence of Cotton Patch Bayou (G110-00-00)

The FEMA (2007) values tabulated above are subject to revision with the ongoing FEMA studies, anticipated to be completed later this year. It is possible that the flood elevations will increase due to the inclusion of recent hurricanes, (notably, Ike) that have impacted HGNC (Houston Galveston Navigation Channel) since 2007, in the ongoing studies.

### 2.6.3 SHIP BLOCK HEIGHT

TPWD requested an increase of block height from 4' to 6' or possibly higher in order to be able to perform repairs on the vessel keel and bottom plating.

AECOM performed a brief review of block heights for navy ships and found the following:

1. Note 5 on the 1927 blocking plan drawing for the (BB-35) states that "Height of blocking not to exceed 5' unless blocking under centerline keel is cribbed". Block dimensions are 4'x4'x1'-2".
2. Unified Facilities Criteria UFC 4-213-10 (successor document to MIL HDBK 1029/1 and DM 29.1) considers a block height range of 4 to 6 feet as "normal". The UFC mentions the use of higher blocking for military ships with bow and sonar domes which extend below keel.
3. Majority of Navy drydocks have block height of 4'
4. Ship Technical Manual Chapter 997 (Current MILCA STD SPEC 8634_STD) on drydocking does not have anything relevant to height of blocks

The conceptual design for the dry berth adopted 6' high blocks. The 6' blocks have an impact on the dry berth cost since they would increase the depth of the dry berth to the TOS (Top of Slab).

### 2.6.4 SHIP STABILITY AND DRAFT ASSUMPTIONS

Stability calculations were performed for two configurations of the vessel:

- Configuration 1 – Current configuration of vessel with Blister Tanks (Vessel Displacement = 25119 LT)
- Configuration 2 – Original configuration of vessel without Blister Tanks (Vessel Displacement = 24637 LT)

Flooding scenarios considered included flooding (from the bottom of the space to the waterline) of the Blister Tanks, Aft Trim Tanks (D-12 and D-13), Boiler Rooms (B-2, B-3 and B-4) and Engine Rooms (C-1 and C-2). Table 2-9 and Table 2-10 show the various flooding scenarios and the corresponding changes in the vessel trim, forward and aft drafts, and list.

**Table 2-9: Flooding Scenarios and Results for Vessel with Blister Tanks**

| Configuration No. 1 - Battleship TEXAS BB-35 Stability Assessment (With Blister Tanks) | | | | | | |
|---|---|---|---|---|---|---|
| Scenario No. | Scenario Description | List (Deg) | Midship Draft (ft) | Trim (ft) | Forward Draft (ft) | Stern Draft (ft) |
| 1 | Intact Stability (Displacement = 25119 LT) | 0.0 | 24.5 | 3.3 | 22.8 | 26.1 |
| 1A | Blister Tanks Flooded | 0.0 | 26.6 | 4.6 | 24.3 | 28.9 |
| 1B | Flood Blister Tanks and Aft Trim Tanks | 0.0 | 26.8 | 6.8 | 23.4 | 30.2 |
| 1C | Flood Blister Tanks, Aft Trim Tanks and Both Engine Rooms | 0.0 | 28.5 | 12.1 | 22.4 | 34.5 |
| 1D | Flood blister Tanks, Aft Trim Tanks, Both Engine Rooms and Three Boiler Rooms | 0.0 | 31.4 | 8.1 | 27.3 | 35.4 |
| 1E | Flood Blister Tanks, Aft Trim Tanks, Three Boiler Rooms and Only Starboard Engine Rooms (To Maximize List) | 4.8 | 30.6 | 5.5 | 27.8 | 33.3 |

**Table 2-10: Flooding Scenarios and Results for Vessel without Blister Tanks**

| Configuration No. 2 - Battleship TEXAS BB-35 Stability Assessment (Blister Tanks Removed) | | | | | | |
|---|---|---|---|---|---|---|
| Scenario No. | Scenario Description | List (Deg) | Midship Draft (ft) | Trim (ft) | Forward Draft (ft) | Stern Draft (ft) |
| 2 | Intact Stability (Displacement = 24637 LT) | 0.0 | 26.1 | 4.8 | 23.7 | 28.5 |
| 2B | Flood Aft Trim Tanks | 0.0 | 26.3 | 7.0 | 22.9 | 29.8 |
| 2C | Flood Aft Trim Tanks and Both Engine Rooms | 0.0 | 28.0 | 12.3 | 21.8 | 34.1 |
| 2D | Flood Aft Trim Tanks, Both Engine Rooms and Three Boiler Rooms | 0.0 | 30.9 | 8.3 | 26.7 | 35.0 |
| 2E | Flood Aft Trim Tanks, Three Boiler Rooms and Only Starboard Engine Rooms (To Maximize List) | 5.2 | 30.1 | 5.7 | 27.2 | 32.9 |

Based on an assessment of the stability as well as general structural condition of the ship, the following recommendations are provided with regard to any dredging (of the current slip) or towing of the ship:

- The need for monitoring of the ship will be required during any dredging at the slip or towing of the ship, due to the very poor material condition of the ship.
- In a floating condition, there is a significant danger of loss of stability for the vessel due to the possibility of up-flooding into large off-center spaces.
- The removal of blister tanks can be expected to lead to an increase in the trim and drafts of the vessel in its intact/undamaged condition due to a reduction in the waterplane area and loss of buoyancy.
- Flooding scenarios considered here indicate that large (several feet, degrees) increases in draft/trim and/or list of the vessel can occur for vessel configurations with or without blister tanks.
- Existing and supplemental pumping capability will be required onboard to keep the vessel stabilized whilst in a 'floating' condition even after temporary repairs have been completed.
- The vessel's bitts and chocks on main deck will require strengthening before the vessel can be towed.
- The underwater hull and interior scantlings need to be significantly reinforced to restore a substantial amount of structural integrity before moving the ship into the Houston Ship Channel.
- Tugs cannot be allowed to push on side plating in order to maneuver the ship
- The use of monopiles remains necessary should the vessel be moored to a temporary location as the vessel's blister tankage is not capable of supporting the side loads of the ship against fendering.

## 2.7 LANDSCAPE ARCHITECTURAL CONSIDERATIONS

The effects of the dry-berthing project on the recognized cultural resources (including the commemorative landscape) were taken into account during the Phase I development of design alternatives. Of particular interest was the visibility of the ship from the battlefield after dry-berthing and the effects of any new circulation systems, proposed planting, and other new visitor facilities on the site's cultural resources. Identified cultural resources adjacent to the ship's berth area include sections of the historic Harrisburg-Lynchburg Road to the south east, the Texan encampment to the south, and possible subsurface archeological resources in various locations. In addition, the ship is visible from virtually the entire battleground as well as from the San Jacinto Monument. Ensuring that proposed new landside facilities do not negatively affect the integrity of these resources was a critical consideration during the development of design alternatives. Maintaining the important historic character of the landscape in order to protect and enhance the visitor experience was an important goal of the Phase I design services.

Visitor facilities for the dry-berthing project will be centered on the enlarged dry berth with pedestrian and service access systems, a visitor facilities building (undertaken as a separate project), parking, planting, and grading to meet existing landside elevations around the proposed dike. The considerations for the landside development included improving access to the ship (pedestrian and vehicular), screening the ship from the Texas encampment location, and creating topographic modifications and planting that are compatible with the historic scene at the battleground. Concepts for the landside developments around the berth were guided in part by the 2004 *Schematic Plan for the San Jacinto Battleground State Historic Site* by EDAW (a legacy AECOM company) and TBG. The program for the landside resources as described in the Schematic Plan in 2004 included visitor parking for 240 cars, bus parking for 15 buses, a small visitor entrance drive, and vegetative screening between the parking and the rest of the battleground, but this program was not re-evaluated for the purposes of the dry berth project.

Landscape architects from AECOM and TBG supported the design of the four dry berth alternatives in several ways. Working with the full AECOM engineering team, landscape architects reviewed concept alternative locations, taking into account the location of important previously-identified cultural resources. They supported the development of design concepts for the alternatives, including proposing the alignment of the accessible path into the berth, grading within the bowl, the alignment of the dike, potential planting locations landside of the dike, planting schemes within the dry berth, and coordination between surface treatment of the dry berth and subsurface drainage infrastructure.

Landscape architects with AECOM and TBG studied different cross-sectional relationships between existing landside topography and proposed facilities within the dry berth to ensure that grading requirements were met and that the planned visitor experience would satisfy the project's objectives.

Throughout the concept alternative development process, team landscape architects participated in planning and design meetings to review and understand the engineering objectives and to help define the planning and technical parameters of the berthing design alternatives. They also analyzed and evaluated the four berthing options for their impact to landside resources and other program requirements, and reviewed associated cost estimates.

## 2.8 CIVIL/UTILITIES

### 2.8.1 STORM WATER SYSTEM

Stormwater runoff volumes and flow, were based on the following different contributing areas of rainfall and are summarized below.

**Table 2-11: Drainage Areas**

| Alternative | Estimated Contributing Drainage Area |
|---|---|
| Alternative 1.2.1/ Option 1 | 7.84 Acres |
| Alternative 1.3/ Option 2 | 9.31 Acres |
| Alternative 2.2B/ Option 3 | 6.90 Acres |
| Alternative 3.0/ Option 4 | 2.42 Acres |

For determining stormwater runoff volumes and flow, the rainfall contributing area was based on the acreage listed in the table, which is the approximate area within the berm and sheet pile structure surrounding the dry berth. The peak runoff rate was calculated using the Rational Method with a C value of 0.95. TxDOT Rainfall intensity/duration curves for Harris County were used to determine the rainfall intensity for a given rainfall event since these are more conservative than the City of Houston curves in that they yield a greater rainfall intensity for a given event and duration. It is assumed that the storm duration is equal to the time of concentration, and that the rainfall intensity is constant during the duration of the storm. Runoff rate starts at zero at the beginning of the storm and increases linearly to the peak flow over the duration of the storm, and decreases back to zero over the same length of time as the duration of the storm. For this conceptual evaluation, the time of concentration was estimated to be 10 minutes. The time of concentration is affected by materials, slopes, and lengths of the various conveyance paths of the runoff to the point of interest, in this case the pump station. Based on rainfall intensity/duration curves, the shorter the time of concentration, and therefore the shorter the duration, the greater the rainfall intensity, and the greater the peak runoff rate.

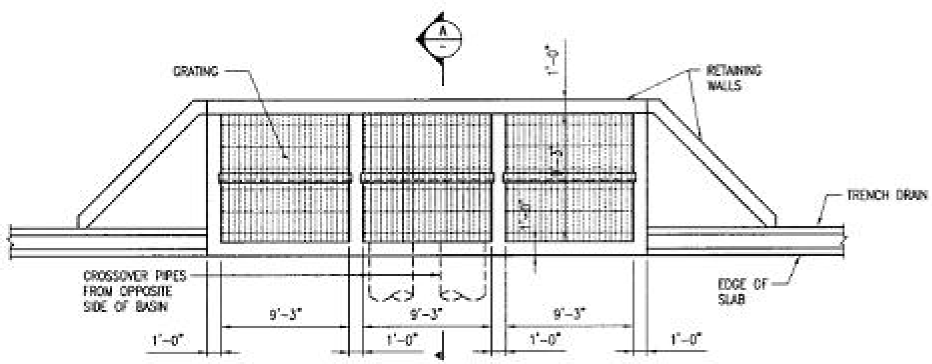
For this analysis, a seepage rate of 20 gallons per day per linear foot (gpd/lf) of perimeter berth slope was used as provided by from HVJ Associates.

The approximate pump size and wet well size is based on the required storage to prevent excess runoff storage (ponding) in the dry dock for the 2 year rainfall event.

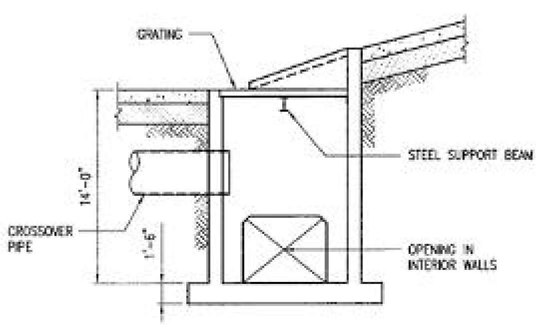
Assuming ponding for the 2-year rainfall event, the following table is a summary of the required dewatering/drainage system.

**Table 2-12: Drainage System Characteristics**

| Dewatering/Drainage System | Alternative | | | |
|---|---|---|---|---|
| | 1.2.1 (Option 1) | 1.3 (Option 2) | 2.2B (Option 3) | 3.0 (Option 4) |
| Pumpwell: | See Sketch | See Sketch | See Sketch | See Sketch |
| Submersible pumps[1] | 3x8,500gpm | 3x7,000gpm | 3x7,000gpm | 3x7,000gpm |
| Cross culverts | 310'x24" | 540'x24" | 310'x24" | 240'x18" |
| Pipes to valve chamber | 420'X18" | 420'X18" | 540'X18" | 300'X14" |
| Valves/Valve chamber | 1-30" gate valve; 1 - 30" Tideflex valve; 3-18" plug valves; 3-18" check valves; 4 air release valves | | | |
| Outfall structure | 315'x30" | 255'x30" | 130'x30" | 550'x24" |
| Note 1: System considers a redundant standby pump. | | | | |




PUMPWELL PLAN
SCALE: 3/32"=1'-0"




A SECTION
SCALE: 3/32"=1'-0"

## 2.8.2 WATER/SEWER

Potable water is supplied to the ship via a 2x4" diameter waterline that crosses over the water at and is supported by the existing gangway. Wastewater from the ship is pumped via a force main that crosses the water and is also supported by the existing gangway, and discharges into an existing sanitary manhole. Since there is no planned change to the capacities of either the water or wastewater system line sizes would remain the same. For the proposed alternative, water and wastewater systems would consist of reconnecting similar size lines to the ship.

### 2.8.3 ELECTRICAL

In the ship's current wet berth, power is provided to the ship from the north side of the ship's berth. There are two power services. One is 480 volts and second I 120/240 volts. The service cables are routed under water on the north side of the ship .The service cables are routed up the ship's side to the electrical connections approximately mid-ship on the main deck. The communication system enters the ship on the south side of the ship just below the main entrance. There are punch down boards and telephone communications. The relocation poses no major problems. Power and communication can be disconnected and relocated by coordination with CenterPoint Energy.

## 2.9 ACCESS

Proposals for access to the base of the ship included a variety of concepts such as separate pedestrian and service access, and combined pedestrian and service access. Eventually the design for the ship access system focused on a single pedestrian/vehicular access path with 5% maximum slopes to enable full visitor accessibility without the need for ramps. Grading within the dry berth was guided by several factors, including stable geotechnical slope requirements and maintenance considerations which suggested a maximum slope of 3:1 in three of the schemes. Given the drainage requirements for the dry berth as well as the possibility that some concept alternatives would permit periodic inundation, careful consideration was given to the treatment of the slopes. A combination of planting schemes within the berth was considered, including areas of native grasses, areas of seeded lawn grasses, or areas with no planting (hard surfaces only).

# 3 EVALUATION OF DRY BERTH OPTIONS

TPWD described the criteria that the dry berth project must meet as follows:

1. The solution must be, within reason, reversible. If the ship should need to be towed or refloated for any reason, it shall remain possible to do so.
2. The solution must visually respect the San Jacinto Battleground site.
3. The solution must be more cost effective than the alternative of conducting a major dry docking every 10-15 years.

## 3.1 EVALUATION OF PROCEANIC OPTIONS

Proceanic proposed four dry berth options:

- Land Based Elevated Scenario
- Sheet piling Graving Dock
- Earthen Berm Graving Dock
- Dedicated Barge/Floating Dock

### 3.1.1 LAND BASED ELEVATED SCENARIO

The land based Elevated scenario was evaluated (See Figures 3-1 and 3-2) and the concept violated the first two criteria listed above by TPWD, namely:

- Reversibility would have been extremely expensive to achieve
- Visual respect of San Jacinto where the top of deck elevation will be at +63' compared to the existing elevation of +25' and the top of mast of the ship will be at +163'.

The Texas Historical Commission (THC) in a letter dated 15 September 2008, stated they considered the land based elevated dry berth scenario as unacceptable due to significant visual incursion on the Battleground site (see Attachment H.) Therefore the concept was judged not viable.

### 3.1.2 SHEET PILING GRAVING DOCK

The concept consists of surrounding the ship with a sheet pile bulkhead on three sides and concrete approach on the south side. We believe the concept is feasible in principle for the dry berth of the TEXAS.

AECOM review of the option is as follows:

1. The cost estimate does not include the rainwater/groundwater pumping system. The system needs to be robust and have redundancy built in. Back-up power may be required.
2. It is unclear why the monopile heights would need to be increased by 8 feet for this alternative. They are only needed when the ship is floating, and it will float at the same range of elevations as presently experienced.
3. The west side closure cofferdam will contain sheeting, which will need to be removed and reinstalled for ship entry. The cost estimate does not include this.
4. The unit costs of pile driving and riprap seem low.
5. The design is not based on any geotechnical information

6. The cost of the temporary berth was not included in the capital cost of the option

### 3.1.3 EARTHEN BERM GRAVING DOCK

The existing slip will be converted to a traditional looking graving dock using stone baskets for the stair stepped sides of the dry berth.

AECOM review of the option is as follows:

1. A pressure relieved dock design is assumed intended rather than a gravity design, since the proposed berm has a permeable stone facing. Also, with a gravity design, the whole deck slab (even beyond the ship footprint) would need pile support or weight to resist uplift.
2. A cutoff wall is likely to be needed inside the berm to slow groundwater intrusion and minimize permanent groundwater pumping requirements. This can be done using sheet piling (of lesser capacity than in the Sheet Piling Graving Dock, where fill is retained) or by jet grouting. The existing sheet piling on the south side of the wet berth may be worth retaining (contrary to cost estimate, which shows removal) to assist in this function.
3. The cost estimate does not include the rainwater/groundwater pumping system. The system needs to be robust and have redundancy built in. Back-up power may be required.
4. It is unclear why the monopile heights would need to be increased by 8 feet for this alternative. They are only needed when the ship is floating, and it will float at the same range of elevations as presently experienced.
5. The west side closure cofferdam will contain sheeting, which will need to be removed and reinstalled for ship entry. The cost estimate does not include this.
6. The unit costs of pile driving and riprap seem low.
7. Durability of the stone baskets is an issue due to corrosion of the steel mesh which could causes stability problems over time. The other alternate is to use stainless steel wiring which could increase the cost of the alternative.
8. The design is not based on any geotechnical information
9. The cost of the temporary berth was not included in the capital cost of the option

### 3.1.4 DEDICATED FLOATING BARGE:

Halcrow, a subconsultant to AECOM, was asked to evaluate the dedicated barge/floating dock for the dry berthing of the Battleship TEXAS.

This concept involves placing the TEXAS on a dedicated barge that will support the ship above the water and be placed into the slip as single entity –essentially a floating dry dock with few special features included. A floating dry dock consists of a barge-like base with wing walls that contain buoyancy tanks and wing walls are required for the lifting process. In order to maintain the visual impact on the landscape, the dry dock wing walls would need to be removed. As stated in the Proceanic conceptual report, access stairs and elevators would need to be provided.

A determination of the approximate dimensions of a floating dry dock capable of supporting the *TEXAS* was performed and the following table shows the results:

| Dry dock Assumed Dimensions for TEXAS | |
|---|---|
| Length Overall (LOA): | 650 feet |
| Beam: | 170 feet |
| Draft: | 16’-3” |
| Freeboard: | 5’-0” |
| Keel to Well Deck: | 21’-3” |
| Displacement: | 12,467 tons |

The required depth to load the TEXAS onto the dry dock assuming 4 feet keel blocks and 4 feet for grounding clearance results in the following required water depth:

| | |
|---|---|
| Dry dock: | 21’ – 3” |
| Keel Blocks | 4’ – 0” |
| Clearance | 4’ – 0” |
| TEXAS draft | 28’ - 6” |
| Total Draft | 57’ – 9” |

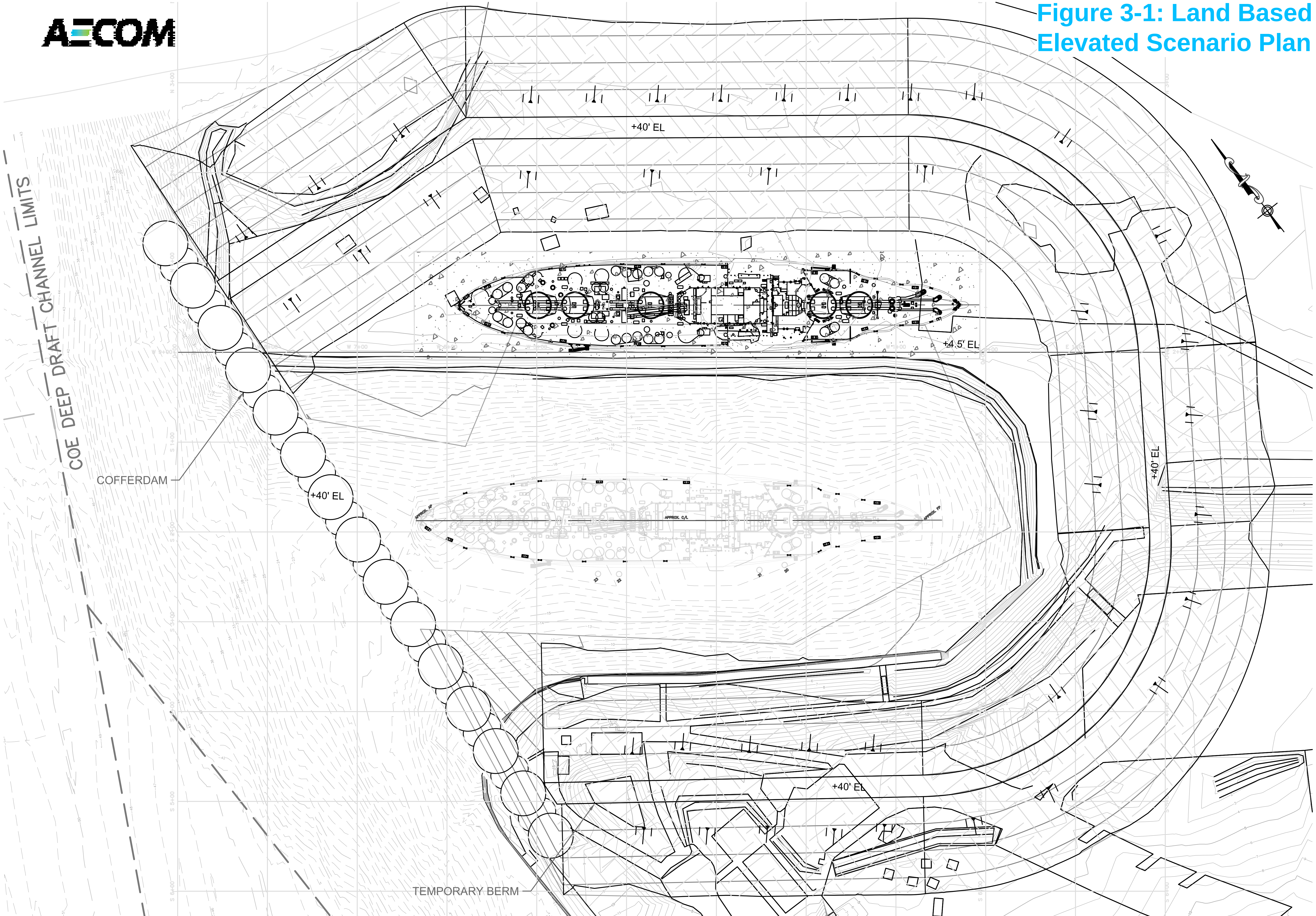
The Proceanic conceptual report stated that there are a few locations within Galveston Bay with 50-55 feet water depth.

The estimated cost of building a new dry dock is about $37.5 million. Additional Costs would consist of:

- Special feature for removable wing walls and access towers
- Removal, transport and storing of the wing walls when not in use
- Dredging costs
- Slip modification to allow a water depth of 60 feet including an overdredge allowance, increasing the cost of the wall and berm for the slip to a prohibitive amount.

The Texas Historical Commission (THC) in a letter dated 15 September 2008, stated they considered the dedicated barge/ floating dry dock scenario as unacceptable due to significant visual incursion on the Battleground site (see Attachment H.) Therefore the concept was judged not viable. See Figures 3-3 and 3-4 for the Floating Dry Dock option.

# Figure 3-1: Land Based Elevated Scenario Plan




TEXAS PARKS & WILDLIFE

AECOM USA GROUP, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TPBE REG. NO. F-3082

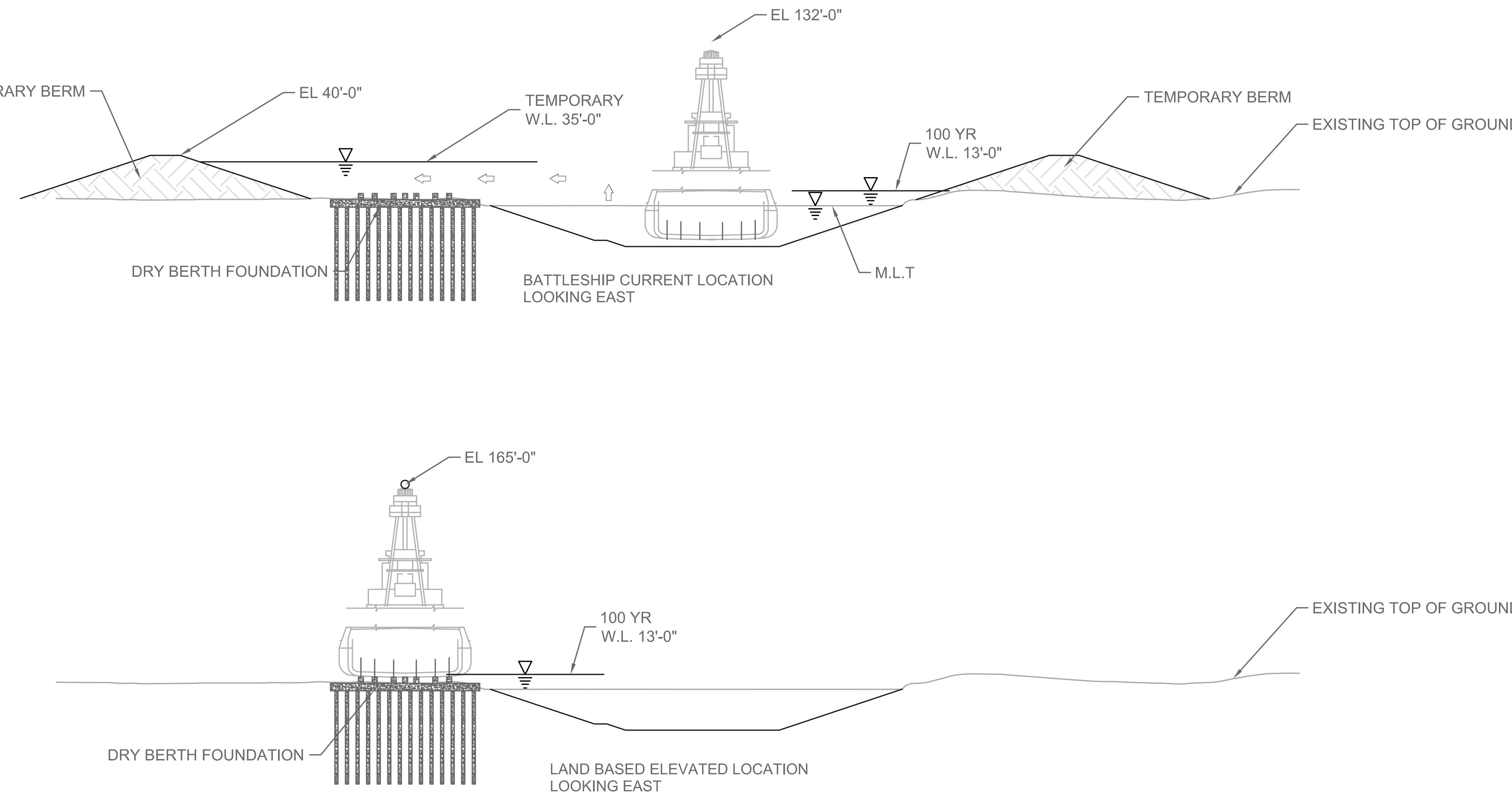
BATTLESHIP TEXAS (BB-35)
LAND BASED ELEVATED LAYOUT - ALTERNATIVE 1
PROJECT NUMBER: 101887
NOT FOR CONSTRUCTION

DATE: 1/20/2011
DESIGNED BY: –
DRAWN BY: DES
REVIEWED BY: JF
REVISED:
REVISED:
REVISED:

SHEET TITLE
LAND BASED ELEVATED LAYOUT ALTERNATIVE 1
-

SHEET NUMBER
06
OF (15)
-

# Figure 3-2: Land Based Elevated Scenario Elevation




TEXAS PARKS & WILDLIFE

AECOM USA GROUP, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TPBE REG. NO. F-3082

NOT FOR CONSTRUCTION

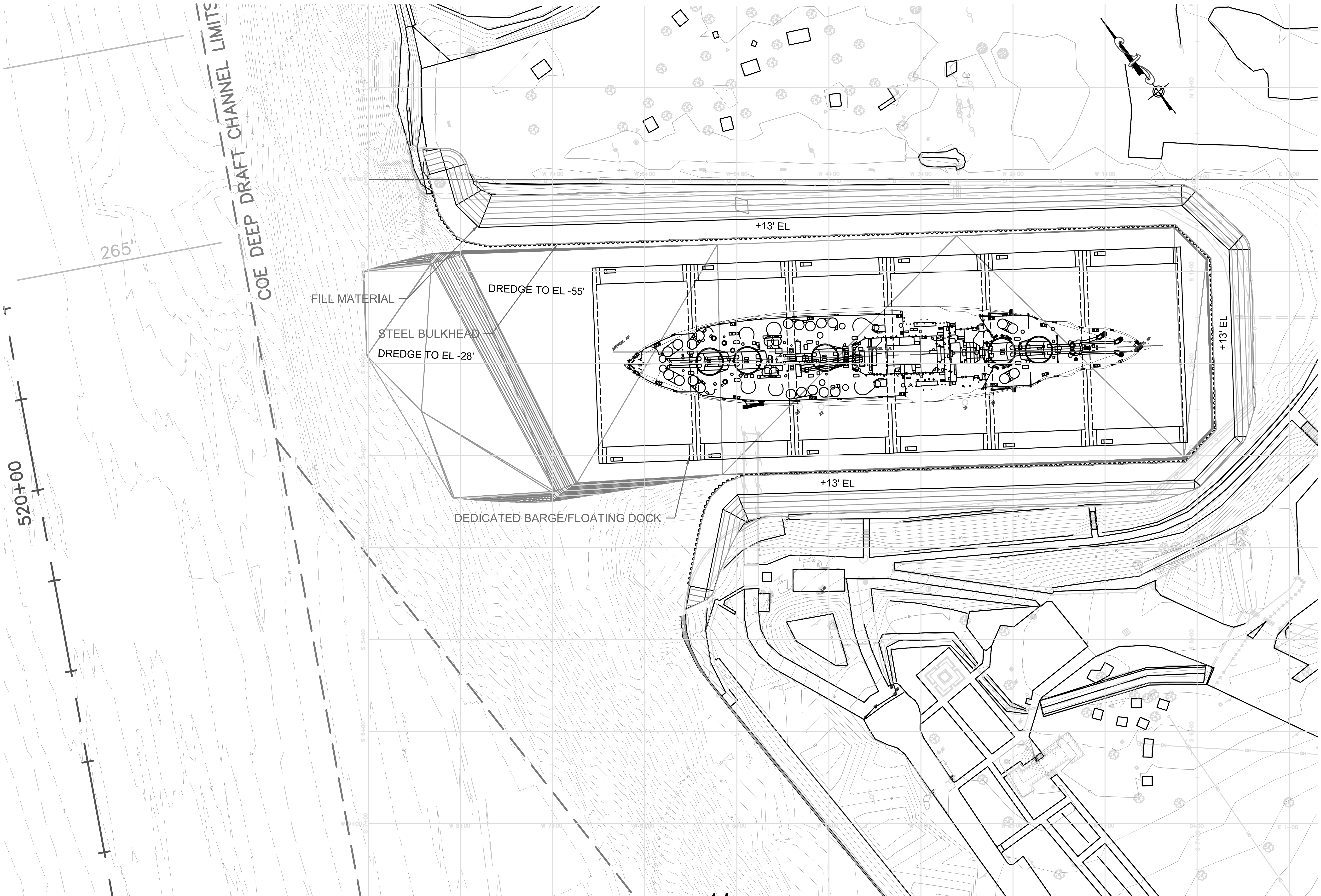
BATTLESHIP TEXAS (BB-35)
LAND BASED ELEVATED SECTION
PROJECT NUMBER: 101887

DATE: 1/5/2011
DESIGNED BY: –
DRAWN BY: DES
REVIEWED BY: JF
REVISED:
REVISED:
REVISED:

SHEET TITLE
LAND BASED ELEVATED SECTION

SHEET NUMBER
07
OF (15)

# Figure 3-3: Dedicated Floating Barge Plan




TEXAS PARKS & WILDLIFE

BATTLESHIP TEXAS (BB-35)
DEDICATED BARGE/FLOATING DOCK LAYOUT - ALTERNATIVE 4
NOT FOR CONSTRUCTION
PROJECT NUMBER: 101887

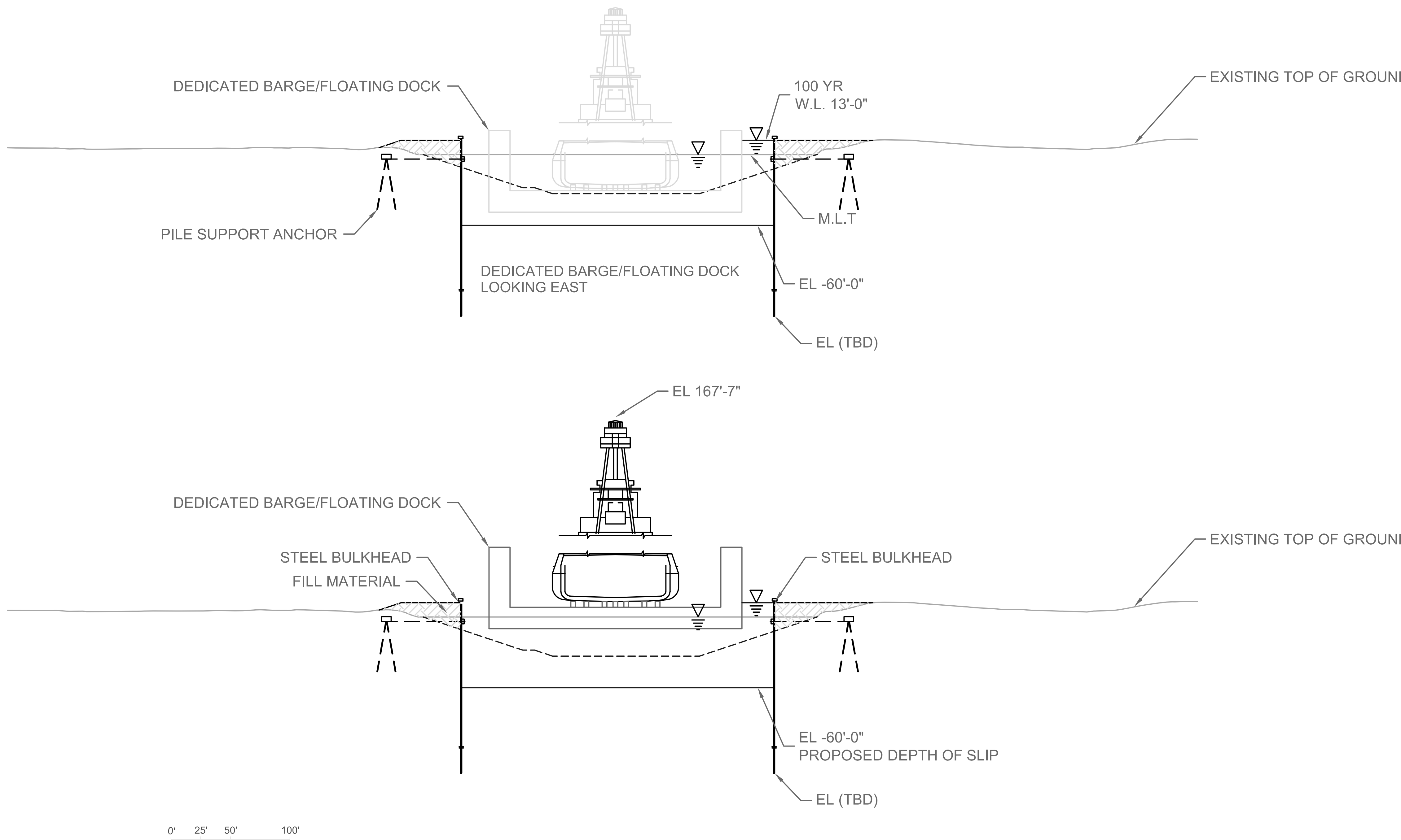
DATE: 1/20/2011
DESIGNED BY: -
DRAWN BY: DES
REVIEWED BY: JF
REVISED:
REVISED:
REVISED:

SHEET TITLE
DEDICATED BARGE / FLOATING DOCK LAYOUT ALTERNATIVE 4

SHEET NUMBER
12
OF (15)

AECOM

# Figure 3-4: Dedicated Floating Barge Section




TEXAS PARKS & WILDLIFE

AECOM
AECOM USA GROUP, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3082

BATTLESHIP TEXAS (BB-35)
DEDICATED BARGE/FLOATING DOCK SECTION - ALT 4
PROJECT NUMBER: 101887
NOT FOR CONSTRUCTION

DATE: 8/29/2011
DESIGNED BY: –
DRAWN BY: DES
REVIEWED BY: JF
REVISED:
REVISED:
REVISED:

SHEET TITLE
DEDICATED BARGE / FLOATING DOCK SECTION ALT 4

SHEET NUMBER
13
OF (15)

# 4 AECOM OPTIONS FOR EXISTING LOCATION

## 4.1 DRY BERTH ALTERNATIVES

When the preliminary results of the TEXAS hull Structural survey and stability analysis were reported to the overall team, AECOM was directed by TPWD to propose alternatives that did not require the TEXAS to be towed into the ship channel. The rationale was based on the draft results of the hull structural survey and the stability evaluation report by the Naval Architect which considered various flooding scenarios during a tow and subsequent change in the draft of the ship and the risks associated with the flooding. It was reasoned that if the TEXAS were to be grounded during a tow, TPWD would be liable to substantial economic damage to the Port of Houston and various industries that utilize the ship channel.

Eight dry berth alternatives were proposed and summarized based on their important parameters including the location of the TEXAS during construction:

1. TEXAS moves to an offsite temporary facility (one alternative)
   a. Alt 1.1 requires an offsite temporary berth was eliminated due to towing risk into the channel.
2. TEXAS moves to temporary wet berth within San Jacinto (four alternatives)
   a. Alt 1.2.1 (0°), 1.2.2 (15°) and 1.2.3 (30°) with different wet berth orientations require onsite superflooding with dry berth slab excavation to elevation -26'. Alt 1.2.1 in line with present berth was selected for final evaluation.
   b. Alt 1.3 with a parallel offset wet berth without onsite superflooding, and with excavated dry berth top of slab to elevation -38' was selected for final evaluation.
3. TEXAS stays in existing wet berth (three alternatives)
   a. Alt 2.2B with location north of existing berth and top of dry berth slab elevation to -38' was selected for final evaluation.
   b. Alt 2.3 with location north of existing berth and top of dry berth slab elevation to -38' was discarded for intrusion further north into the wetland.
   c. Alt 3.0 with location northeast of existing berth and top of dry berth slab elevation to -38' was selected for final evaluation because of its method of construction (slurry wall), durability of concrete walls and the requirement of wetting and drying the berth for an extended period of time.

Table 4-1 presents a summary of important parameters for the eight alternatives and notation of the alternatives discarded and the ones that made it to the final four. Table 4.2 presents a summary of the final dry berth alternatives.

## 4.2 FINAL DRY BERTH ALTERNATIVES

### 4.2.1 ALTERNATIVE 1.2.1 (Option 1)

Option 1 would utilize TEXAS' current berth location for construction of the dry berth. A cantilevered king pile bulkhead would separate the wet berth from the waters of the Houston Ship Channel, and sloped earthen revetments, or retaining walls, would be excavated around the perimeter of the dry berth. The layout would retain the existing south side bulkhead.

During construction, the battleship would be transferred to a temporary wet berth located east of her current position. This wet berth would be comprised of temporary sheet piles and located just west of Independence Parkway. This temporary berthing option precludes risks associated with towing TEXAS into the Houston Ship Channel, and it provides a direct, straight pathway for TEXAS into and out of the wet berth.

This option proposes to construct the closure cofferdam on the west, and the dikes on the other sides, before transferring the ship to the wet berth. With the top of the entire perimeter of the dry and wet berths elevated above Elevation +13 feet for flood protection, water would be pumped into the dry and wet berths to raise their water level to Elevation +12 feet, thereby raising the ship from its present position. The ship would be transferred to the wet berth while this superflooded elevation is maintained, and would remain in this elevated position in the wet berth for the remainder of construction. This approach minimizes the amount of dredging needed for ship transfer, and allows the dry berth slab to be constructed at relatively shallow Elevation -26 feet, minimizing dry berth excavation and footprint.

Once the ship is moved, the dry berth would be dewatered to allow construction of the keel block foundation and excavation of revetment slopes. The foundation would be pile-supported, with hydraulic uplift pressure relieved by a grid of under-drain pipes collecting seepage water beneath the dry berth foundation. Once construction of the foundation is complete, keel blocks would be laid down and the dry berth would again be superflooded to meet the elevated water level in the wet berth.

The west wall of the wet berth would be breeched so that TEXAS could be transferred into her new home. Bringing the pool elevation back down, TEXAS would be seated onto the keel blocks and then secured into a location about 65 feet west of her existing location. The temporary wet berth would be deconstructed and construction the eastern portion of the dry berth would be completed.

Following her placement on the keel blocks, TEXAS would be approximately 5 feet above her current height, providing a minimal increase in visual impact on the site. The basin walls of Option 1 would be vegetated slopes, with a wrap-around access ramp leading down to the basin slab.

Visitor and maintenance access to the ship would be achieved through a gangway located on the north side of the dry berth. Supplementary egress would be provided by staircase on the south side of the ship, extending from TEXAS' main deck down to the basin slab.

One disadvantage of the superflooding concept is that reversibility – the ability to launch a refurbished TEXAS into the channel at a future date - would be a complex and expensive proposition. All four of the dry berth options presented are reversible, although the amount of effort and money required to achieve reversibility varies from option to option. The unique superflooding aspect of Option 1, however, dictates that the ship would rest in her new dry berth at a height that would not allow her to float off the blocks at the channel's normal water levels. This makes the reversibility of this option the most complex of the options considered.

See Figure 4-1 for important details of Option 1 and Rendering in Figure 4-9.

### 4.2.2 ALTERNATIVE 1.3 (Option 2)

Option 2 is similar to the previous option, but without superflooding. It also includes vegetated, sloped revetments constructed within the site of TEXAS' current wet berth. Without the process of superflooding, this option would require a deeper foundation at Elevation -38 feet, 12 feet lower than Option 1. Because of this added depth, the width of the entire dry berth would be greater, and there would be greater land-side impacts directly north of the existing berth.

To protect the existing south side bulkhead from undermining by the proposed excavation, the dry berth and the temporary wet berth would be offset about 65 feet north of the ship's existing location. Following construction of the dry berth, TEXAS would be about 7 feet lower than her existing height, offering less of a visual impact to the battleground site.

See Figure 4-2 for important details of Option 2 and Rendering in Figure 4-10.

### 4.2.3 ALTERNATIVE 2.2B (Option 3)

Option 3 offers a different siting location, utilizing land just north of the current mooring location. Like Option 2, a foundation depth of -38 feet is needed. This option has the largest land-side impact of the alternatives presented here, and has wetland impact as well.

Unlike the previous options presented, TEXAS would remain in her existing location during construction, with only minimal modifications to existing ship utility services required. Besides reducing the amount of temporary work needed, this feature would allow TEXAS to remain open to visitors throughout the dry berth construction process. The dry berth construction would likely be an interesting attraction for visitors to the site, to the extent that construction zone access could be safely allowed.

As in Option 2, TEXAS would rest 7 feet lower than the existing height when seated on the keel blocks. Like the previous design options, the basin walls of Option 3 would be vegetated slopes, with a wrap-around access ramp down to the basin foundation.

Dredging of the western section of the existing wet berth and the new dry berth would be required for this design option, and this is the only option that would require that TEXAS be towed into the Houston Ship Channel to enter the dry berth. Given the results of recent hull assessment surveys and HDS data, TEXAS' voyage into the Houston Ship Channel, although of short duration, could be risky. It would also require U. S. Coast Guard permitting.

See Figure 4-3 for important details of Option 3 and Rendering in Figure 4-11.

### 4.2.4 ALTERNATIVE 3.0 (Option 4)

Option 4 differs from the previous alternatives in terms of structural design and placement of the battleship itself. The dry berth would be constructed northeast of the existing mooring location, and would be constructed using an anchored reinforced concrete slurry wall around the perimeter of the berth and a cantilevered steel king pile wall at its entrance. The ship would be berthed diagonally in relation to her current position, and she would be dry berthed in close proximity to Independence Parkway.

This option would result in the smallest footprint of the four options considered, and it would also allow TEXAS to remain at her existing mooring during construction. As in Option 3, visitors would be allowed on the vessel throughout the dry berth construction process.

Although this option is located closer to the San Jacinto Monument, TEXAS would rest 7 feet lower than her existing height, reducing visual impacts to the battleground. A wrap-around ramp would provide access to the basin foundation, providing at-grade access on the south side of the dry berth. Unlike the other three alternatives, the service facilities and main access gangway would be located south of the dry berth. This option would provide an auxiliary gangway on the north for supplementary egress and maintenance use. This option also allows the flexibility to intentionally flood the dry berth for extended periods of time with minimal impact to the dry berth structure.

See Figure 4-4 for important details of Option 4 and Rendering in Figure 4-12.

## 4.3 SUMMARY OF FINAL DRY BERTH ALTERNATIVES

A summary of the dry berth Alternatives important parameters is shown in Table 4-2.

## 4.4 DRY BERTH FOUNDATIONS

The blocking plan for the TEXAS was based on the 1927 docking plan that was obtained by OTS from the Navy Bureau of Yards and Docks. Figure 4-5 shows reconstitution of the blocking plan. The blocking plan was used in order to determine the load distribution at the required ship draft and calculate the load to be resisted by the drilled shafts. Figure 4-6 shows the piling and framing plans for the dry berth. Figure s 4-7/4-8 shows the base slab configuration and the interface between slab foundation, revetment slopes and the drainage system.

## 4.5 RATING CRITERIA

TPWD described the criteria that the dry berth project must meet:

- The solution must be, within reason, reversible. If the ship should need to be towed or refloated for any reason, it shall remain possible to do so.
- The solution must visually respect the San Jacinto Battleground site.
- The solution must be more cost effective than the alternative of conducting a major dry docking every 10-15 years.

Other rating criteria were selected for their impact on the dry berth project including the requirement for a temporary facility, cost and constructability, permitting, resources impact, and navigational considerations.

The following criteria were adopted for the rating the different Alternatives:

1. Reversibility
2. Visual Respect of San Jacinto
    - Orientation
    - Landscaping
    - Height of Main Deck
3. Requirement of Temporary Facility

4. Storm Water Drainage
5. Seepage Drainage
6. Capital Cost
7. Maintenance Cost
8. Cost-Effectiveness vs. Dry Docking
9. Constructability Issues
    - Working Areas for Construction
    - Material Areas for Offloading
10. Permitting Issues
    - Wetland Impacts
    - Dredging and Dredged Material Disposal
11. Resources Impact
    - Cultural Impact on Site
    - Critical Habitat
12. Navigational Considerations
    - Trip & Tow Plan
    - Navigational risk in Channel
    - Coast Guard Permit

Table 4-3 presents the rating criteria and their relevance on the different options.

## 4.6 RANKING OF ALTERNATIVES

A weight was given to the twelve criteria listed section 4.4. A rating score was assigned to each of the rating criteria for the differing Alternatives. The rating score varied from 1 to 5, 1 being the least favorable. The sums of the weighted scores (weight times rating score) were compared and the Alternatives were classified based on the highest score being ranked first. This method resulted in a relative ranking (against each other) of the alternatives based on a subjective assignment of weights and rating score of each alternative for the relevant criteria. The weight and rating scores were initially assigned by AECOM and upon review by TPWD direction was given to modify certain weights and ratings scores.

Table 4-4 shows the ranking of the Alternatives.

### Table 4-1: Summary of Eight Dry Berth Alternatives Important Parameters

| Alternative | Components | | | Elevations of Dry Berth | | | Ship Parameters | | Wet Berth Elevations | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | West Closure | North Wall | South Wall | Top of Wall | Top of Dike | Top of Basin Slab | Main Deck Elev. at Gangway[1] | Ship Location During Construction | Base of Excavation | Top of Wall | |
| 1.1 | King Pile Wall | Earth revetment | Earth revetment plus bulkhead | +14 | +14 | -38 | 18 | Off site | N/A | N/A | Existing south bulkhead will need strengthening due to depth and proximity of excavation |
| 1.2.1 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -26 | 30 | Onsite superflooded wet berth | +20 | +13 | Wet berth in line with present berth |
| 1.2.2 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -26 | 30 | Onsite superflooded wet berth | +20 | +13 | Wet berth 15 deg off present berth |
| 1.2.3 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -26 | 30 | Onsite superflooded wet berth | +20 | +13 | Wet berth 30 deg off present berth |
| 1.3 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -38 | 18 | Onsite wet berth, not superflooded | +32 | +7 | Wet berth parallel to present berth; dry and wet berths offset 65' north to protect existing south bulkhead |
| 2.2B | King Pile Wall | Earth revetment | King Pile Wall | +14 | +14 | -38 | 18 | Existing berth | N/A | N/A | Berth excavated onshore, north of existing berth |
| 2.3 | Cellular Cofferdam | Earth revetment | Earth revetment | +14 | +14 | -38 | 18 | Existing berth | N/A | N/A | Berth excavated onshore, far north of existing berth |
| 3.0 | King Pile Wall | Anchored Slurry Wall | Anchored Slurry Wall | +13 | N/A | -38 | 18 | Existing berth | N/A | N/A | Berth excavated onshore, northeast of existing berth |

Notes:

1: Assumes deck height 50' above keel. For dry berths, assumes 6' block height. For existing, assumes tide at MSL.

| | |
|---|---|
| (green) | Final Alternatives |
| (orange) | Discarded Alternatives: Alt 1.1 Risks associated with towing TEXAS into the channel; alt 1.2.2/1.2.3 similar to 1.2.1 except for orientation of wet Berth; Alt 2.3 for more Intrusion north into wetlands |

**Table 4-2: Summary of Final Dry Berth Alternatives Important Parameters**

| Alternative | Components | | | Elevations of Dry Berth | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | West Closure | North Wall | South Wall | Top of Wall | Top of Dike | Top of Basin Slab | Main Deck Elev. at Gangway[1] | Diff Elv Between Existing & Proposed | Ship Location During Construction | |
| Existing | N/A | N/A | N/A | N/A | N/A | N/A | +25 | | N/A | Main deck elevation varies with tide; +30' at MSL[2] |
| Alternative 1.2.1/ Option 1 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -26 | 30 | 5 | Onsite superflooded wet berth | Wet berth offset 20' north of present berth |
| Alternative 1.3/ Option 2 | King Pile Wall | Earth revetment | Earth revetment | +13 | +14 | -38 | 18 | -7 | Onsite wet berth, not superflooded | Dry berth offset 45' north to protect existing south bulkhead from deep excavation. Wet berth parallel to present berth, offset 65' north |
| Alternative 2.2B/ Option 3 | King Pile Wall | Earth revetment | King Pile Wall | +13 | +14 | -38 | 18 | -7 | Existing berth | Berth excavated onshore, north of existing berth |
| Alternative 3.0/ Option 4 | King Pile Wall | Anchored slurry wall | Anchored slurry wall | +13 | 14 | -38 | 18 | -7 | Existing berth | Berth excavated onshore, northeast of existing berth |

Notes:

1: Assumes deck height 50' above keel. For dry berths, assumes 6' block height. For existing wet berth, assumes tide at MSL.

2: MSL: Mean Sea Level

## Table 4-3: Rating Criteria & Commentary

| Rating Criteria | | Rating Commentary | | | |
|---|---|---|---|---|---|
| | | Alt. 1.2.1 (Option 1) | Alt. 1.3 (Option 2) | Alt. 2.2B (Option 3) | Alt. 3.0 (Option 4) |
| 1 | Reversibility | Need to create adjacent basin deeper than dry berth to allow exit of ship to channel at normal non-superflood water level. | Needs disassembly of king pile wall; needs more dredging than 2.2B | Only needs disassembly of king pile wall | Needs more dredging than other options to access navigation channel |
| 2 | Visual Respect of San Jacinto | | | | |
| | 2.1 Orientation | Same as existing | Same as existing | Offset from existing | Does not conform to any theme |
| | 2.3 Landscaping | Sloped revetments both sides | Sloped revetments both sides | South slope truncated | No landscaping in basin |
| | 2.3 Height of Main Deck | 5 ft higher than existing | 7 ft lower than existing | 7 ft lower than existing | 7 ft lower than existing |
| 3 | Requirement of Temporary Facility | Needs onsite wet berth | Needs onsite wet berth | None needed | None needed |
| 4 | Storm Water Drainage | With shallow basin, footprint smaller than 1.3 | Large footprint | With small south slope, less footprint than 1.1 and 1.3 | Min. footprint |
| 5 | Seepage Drainage | With shallow basin, less driving water pressure | Full depth basin | South wall reduces inflow | Perimeter walls reduce inflow |
| 6 | Capital Cost | Need wet berth construction and removal | Need wet berth construction and removal | Need south cofferdam wall constructed in wet | Walls constructed from shore; minimum excavation |
| 7 | Maintenance Cost | Correlated with drainage volume and landscaping care | Correlated with drainage volume and landscaping care | Correlated with drainage volume and landscaping care | Min. seepage; no vegetation to tend |
| 8 | Cost-Effectiveness vs. Dry Docking | | | | |
| 9 | Constructability Issues | | | | |
| | 9.1 Working Areas for Construction | Wet berth disrupts site | Wet berth disrupts site | Dry berth disrupts remote north zone | Dry berth disrupts northeast zone, closer to park activities |
| | 9.2 Material Areas for Offloading | Wet berth restricts access from east | Wet berth restricts access from east | Access only available from east | Access available from north and south |
| 10 | Permitting Issues | | | | |
| | 10.1 Wetland Impacts | Minimal impact | Minimal impact | NW corner of dry extends offshore | Minimal impact |
| | 10.2 Dredging and Dredged Material Disposal | Superflooding minimizes required dredging | Needs dredging for side move of ship | Need to dredge passageways out of present berth and into dry berth | Needs wide passageway for move along curve |
| 11 | Resources Impact | | | | |
| | 11.1 Cultural Impact on Site | Wet berth close to battleground | Wet berth moderately close to battleground | Distant from battleground | Part of dry berth moderately close to battleground |
| | 11.2 Critical Habitat | | | Wetland impact | |
| 12 | Navigational Considerations | | | | |
| | 12.1 Trip & Tow Plan | Lateral move off monopiles, then straight move to wet berth | Lateral move off monopiles, then straight move to wet berth | Although moves are not complex, they need to be coordinated with channel traffic | Complex move on arc |
| | 12.2 Navigational risk in Channel | Ship does not enter channel | Ship does not enter channel | Ship enters channel briefly for transfer | Ship does not enter channel |
| | 12.3 Coast Guard Permit | Avoids channel | Avoids channel | Enters channel for transfer | Avoids channel |

**Table 4-4: Rating Criteria & Ranking of Alternatives**

| Rating Criteria | | Weight | Rating Scores (5 = favorable / 1 = unfavorable) | | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | Alt. 1.2.1 Option 1 | Alt. 1.3 Option 2 | Alt. 2.2B Option 3 | Alt. 3.0 Option 4 | |
| 1 | Reversibility | 5 | 1 | 4 | 5 | 3 | |
| 2 | Visual Respect of San Jacinto | | | | | | |
| | 2.1 Orientation | 4 | 5 | 5 | 4 | 3 | |
| | 2.3 Landscaping | 2 | 5 | 5 | 4 | 2 | |
| | 2.3 Height of Main Deck | 5 | 3 | 4 | 4 | 4 | Lower more favorable than higher |
| 3 | Requirement of Temporary Facility | 2 | 1 | 1 | 5 | 5 | |
| 4 | Storm Water Drainage | 2 | 3 | 2 | 4 | 5 | |
| 5 | Seepage Drainage | 1 | 4 | 3 | 4 | 5 | |
| 6 | Capital Cost | 5 | 5 | 2 | 3 | 2 | |
| 7 | Maintenance Cost | 5 | 3 | 2 | 2 | 4 | |
| 8 | Cost-Effectiveness vs. Dry Docking | | | | | | |
| 9 | Constructability Issues | | | | | | |
| | 9.1 Working Areas for Construction | 2 | 2 | 2 | 4 | 3 | Judged based on park impact. |
| | 9.2 Material Areas for Offloading | 1 | 3 | 3 | 2 | 4 | |
| 10 | Permitting Issues | | | | | | |
| | 10.1 Wetland Impacts | 3 | 5 | 5 | 3 | 5 | |
| | 10.2 Dredging and Dredged Material Disposal | 3 | 5 | 3 | 2 | 3 | Delete criterion. Include effect in capital cost. |
| 11 | Resources Impact | | | | | | |
| | 11.1 Cultural Impact on Site | 5 | 3 | 4 | 5 | 4 | Assumed correlated with distance to battleground and associated footprint. |
| | 11.2 Critical Habitat | 4 | 5 | 5 | 3 | 5 | Assumed correlated with wetland impact. |
| 12 | Navigational Considerations | | | | | | |
| | 12.1 Trip & Tow Plan | 2 | 5 | 5 | 3 | 4 | |
| | 12.2 Navigational risk in Channel | 4 | 5 | 5 | 3 | 5 | |
| | 12.3 Coast Guard Permit | 3 | 5 | 5 | 3 | 5 | |
| | | Weighted Scores | 219 | 215 | 205 | 223 | |
| | | Ranking | 2 | 3 | 4 | 1 | |

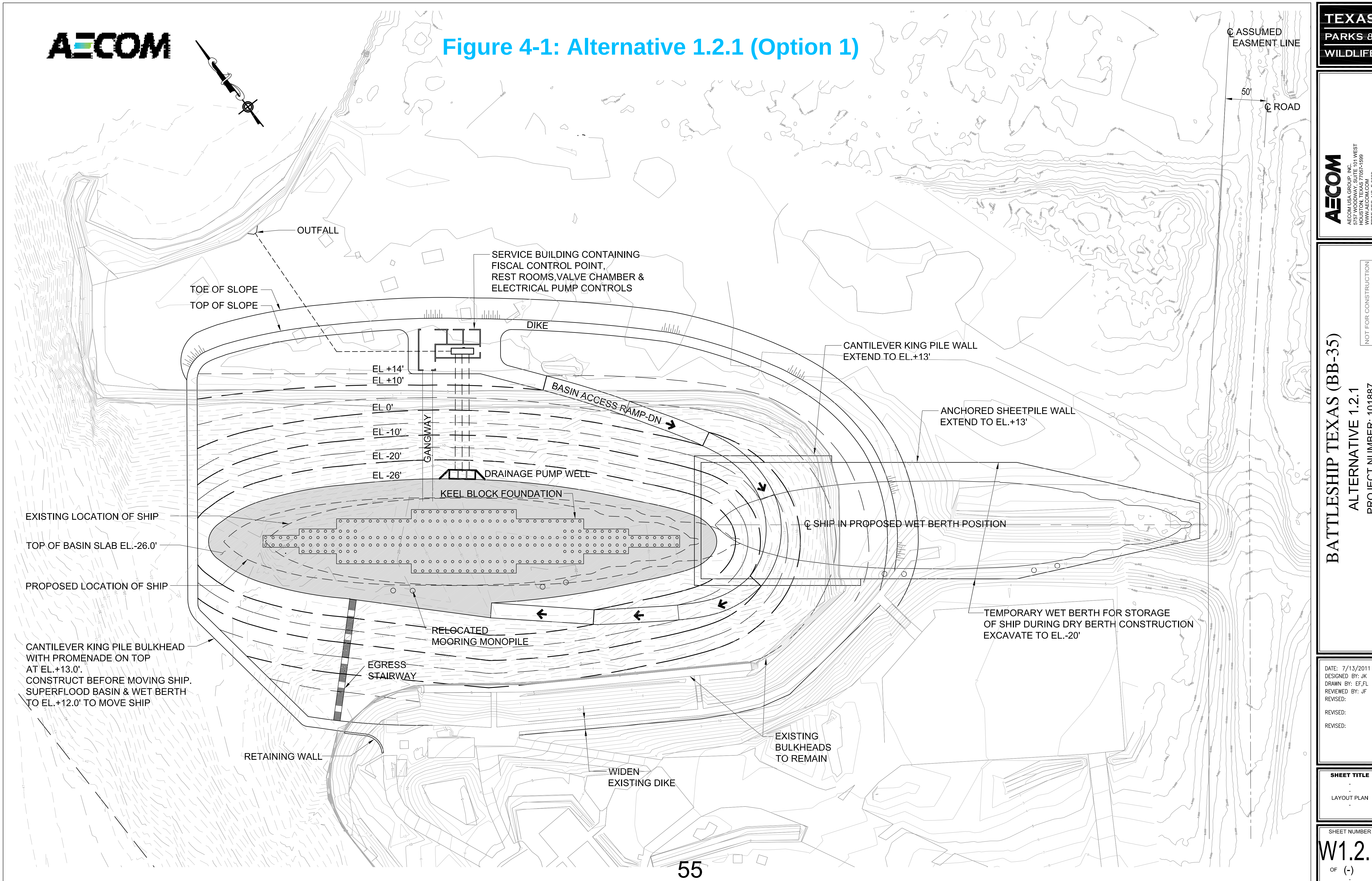



**Figure 4-1: Alternative 1.2.1 (Option 1)**

# Figure 4-2: Alternative 1.3 (Option 2)

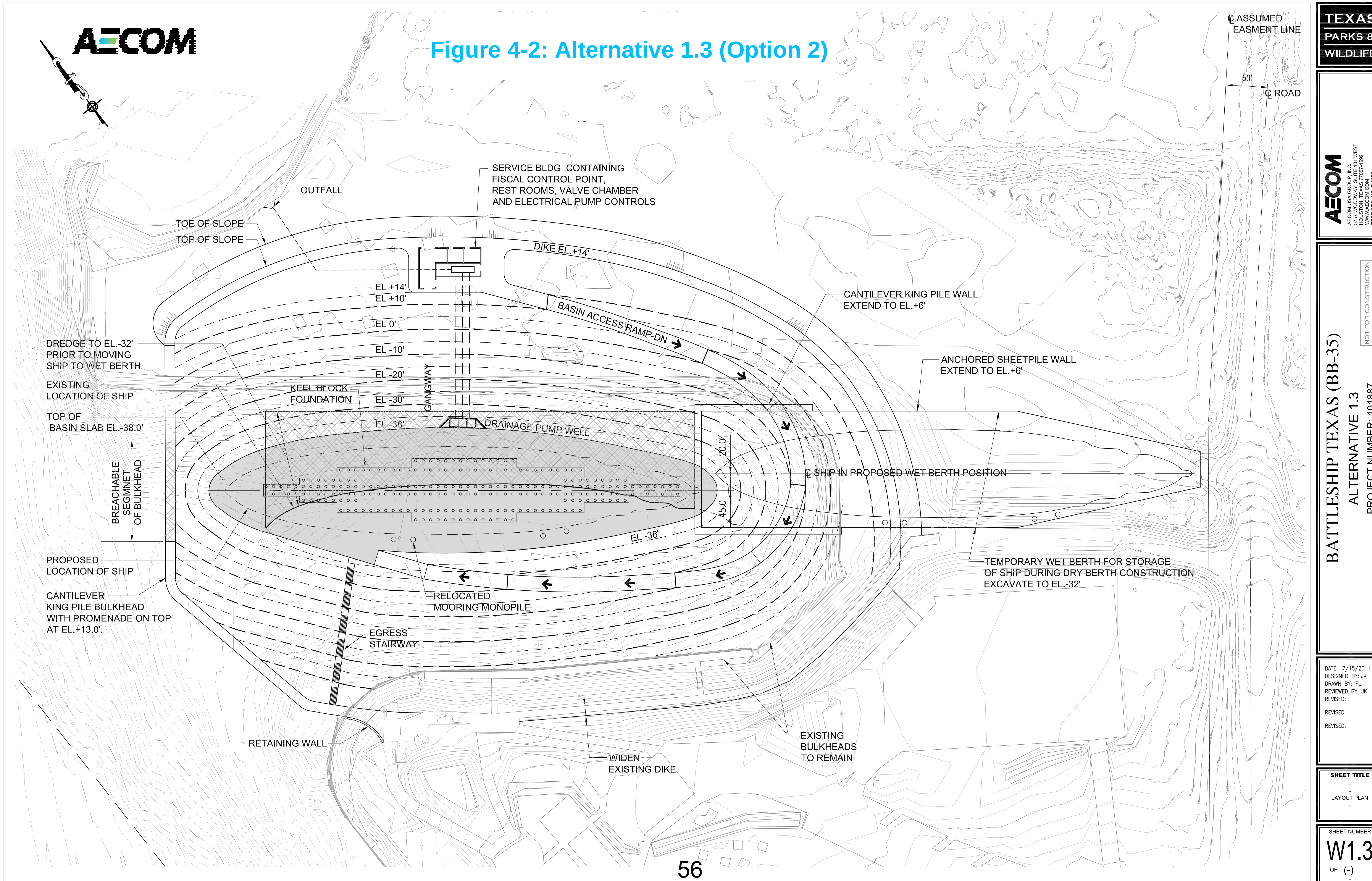
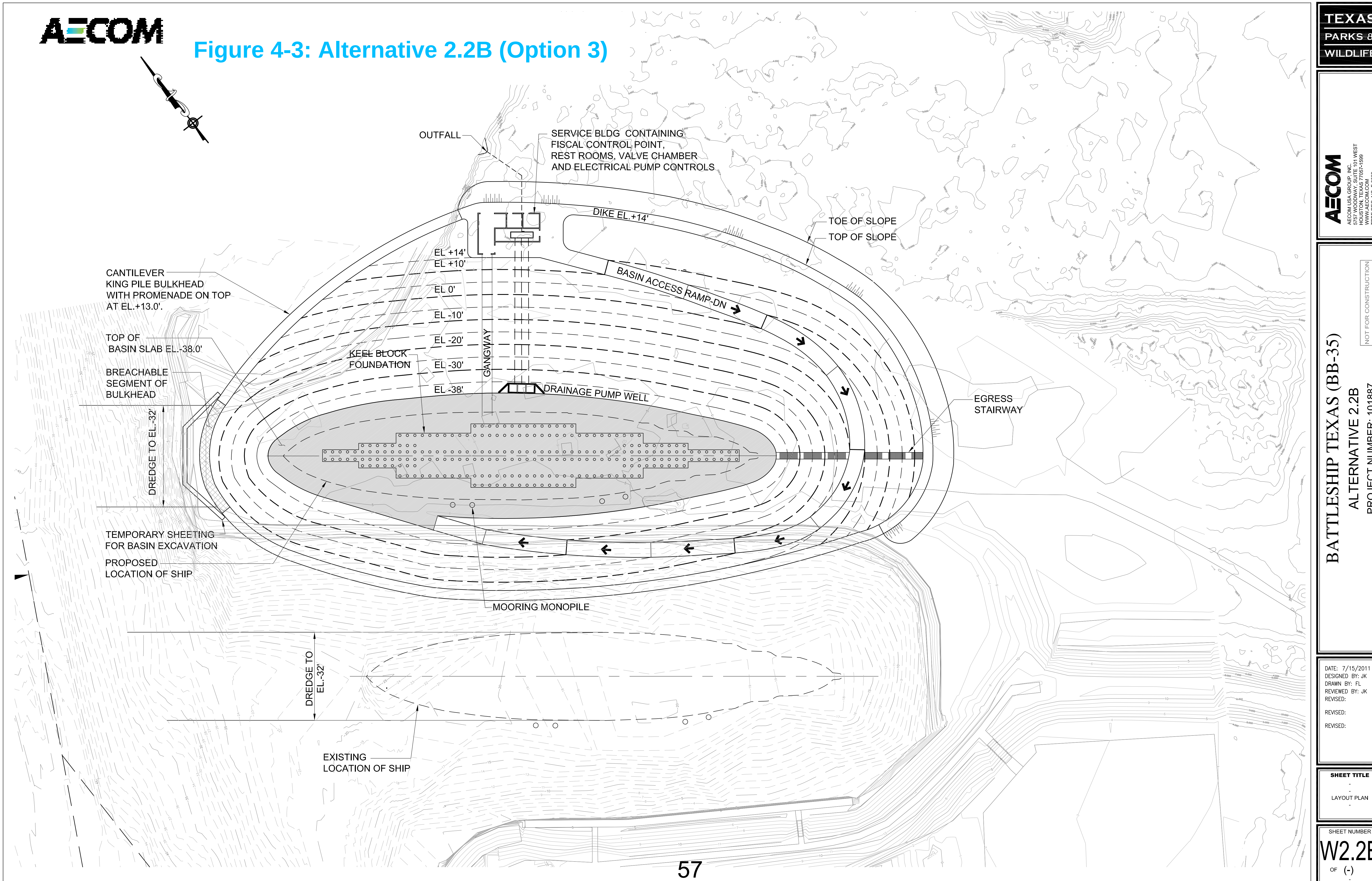
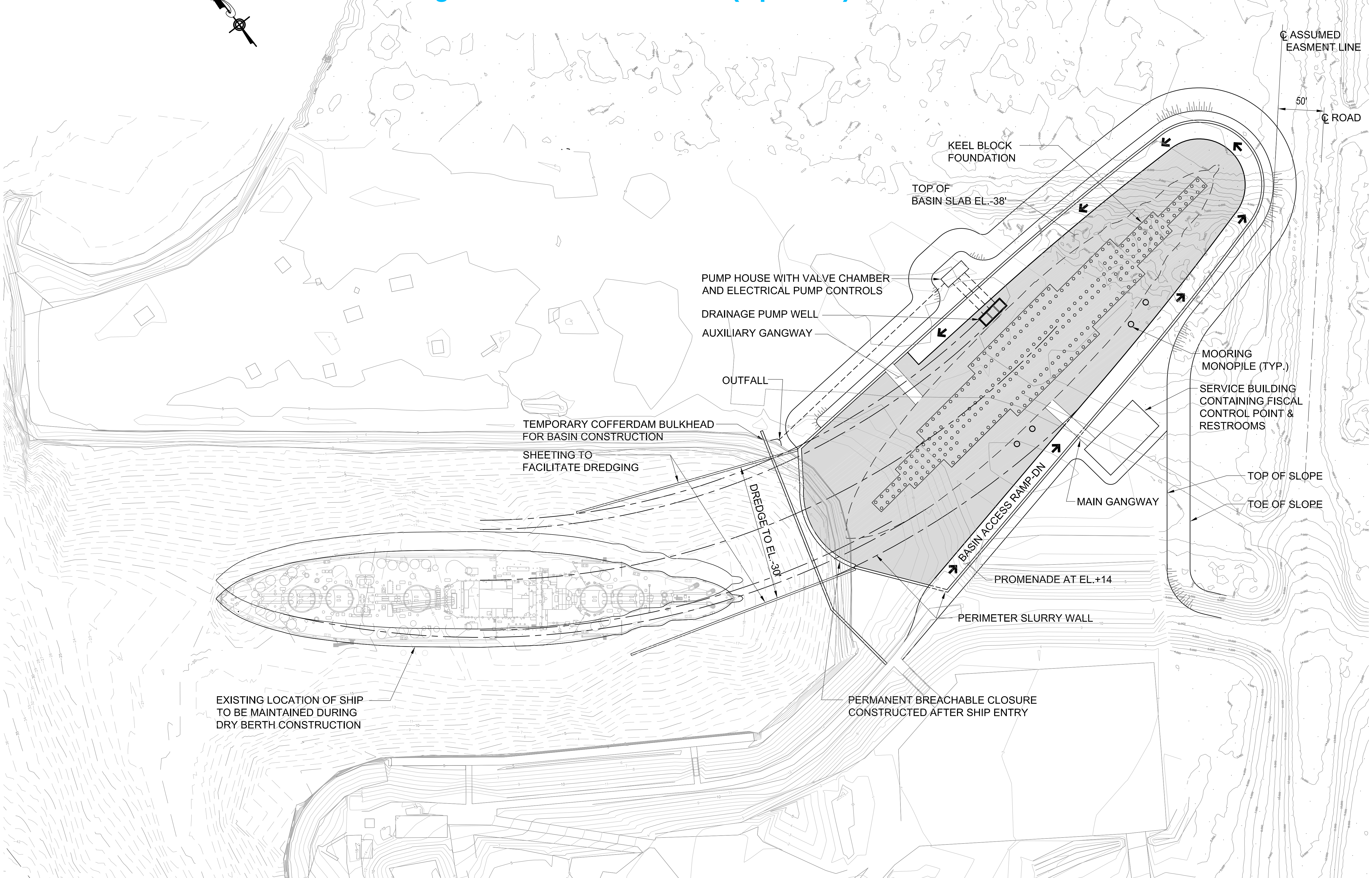


Figure 4-3: Alternative 2.2B (Option 3)



# Figure 4-4: Alternative 3.0 (Option 4)




TEXAS PARKS & WILDLIFE

AECOM USA GROUP, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3082

BATTLESHIP TEXAS (BB-35)
ALTERNATIVE 3.0A
PROJECT NUMBER: 101887

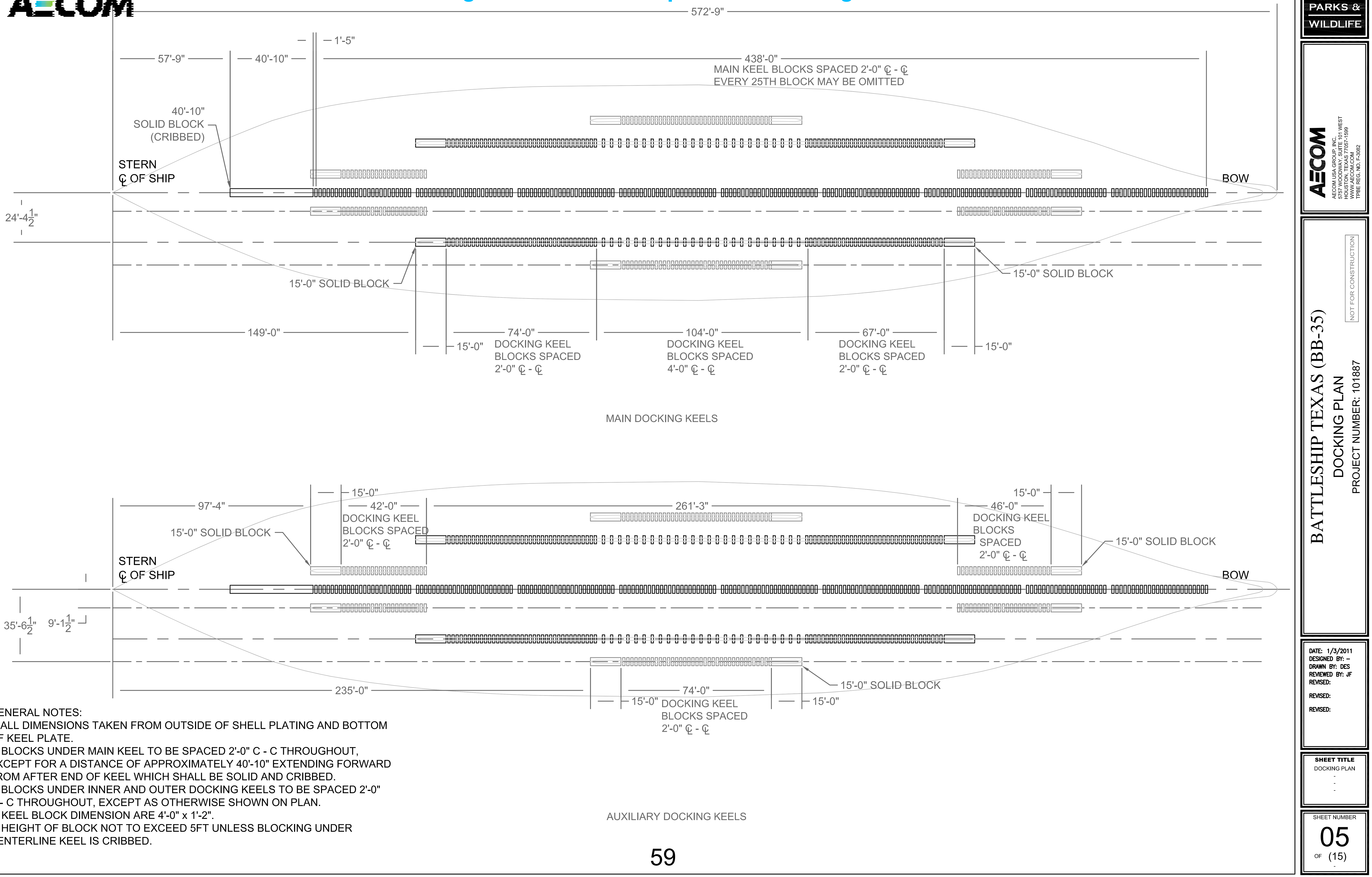
NOT FOR CONSTRUCTION

DATE: 7/14/2011
DESIGNED BY: JK
DRAWN BY: FL
REVIEWED BY: JK
REVISED:
REVISED:
REVISED:

SHEET TITLE
LAYOUT PLAN

SHEET NUMBER
W3.0A
OF (-)

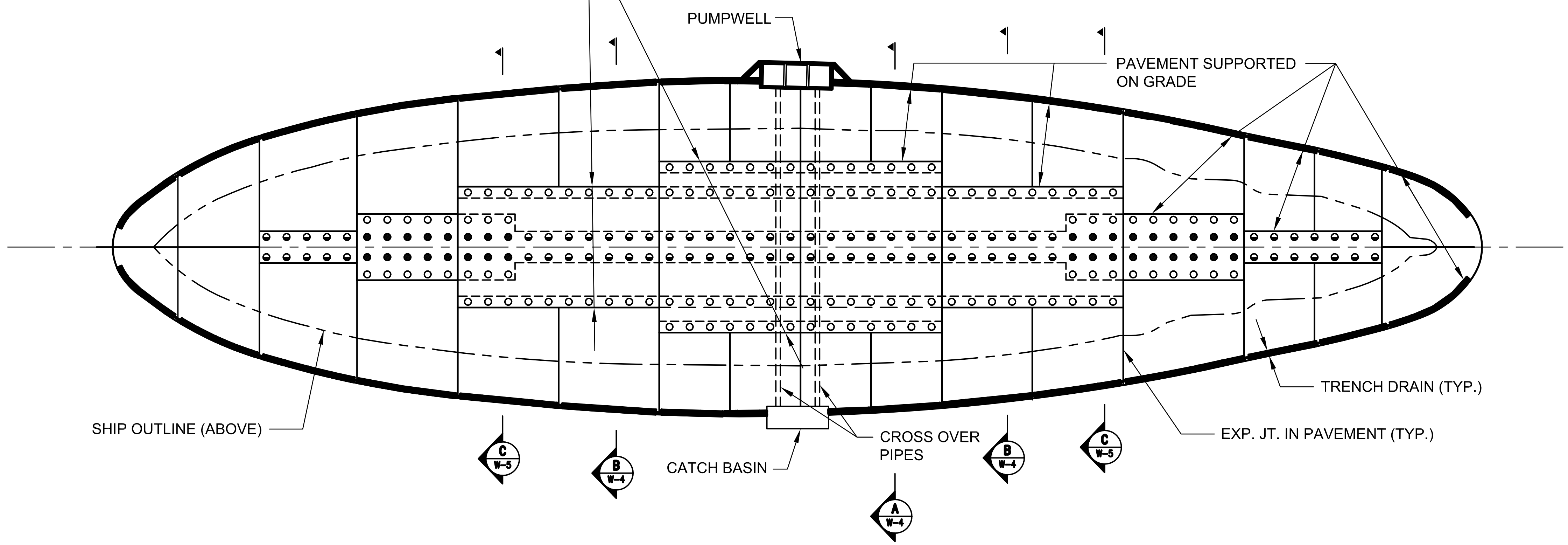
# Figure 4-5: Battleship Texas Docking Plan




GENERAL NOTES:
1. ALL DIMENSIONS TAKEN FROM OUTSIDE OF SHELL PLATING AND BOTTOM OF KEEL PLATE.
2. BLOCKS UNDER MAIN KEEL TO BE SPACED 2'-0" C - C THROUGHOUT, EXCEPT FOR A DISTANCE OF APPROXIMATELY 40'-10" EXTENDING FORWARD FROM AFTER END OF KEEL WHICH SHALL BE SOLID AND CRIBBED.
3. BLOCKS UNDER INNER AND OUTER DOCKING KEELS TO BE SPACED 2'-0" C - C THROUGHOUT, EXCEPT AS OTHERWISE SHOWN ON PLAN.
4. KEEL BLOCK DIMENSION ARE 4'-0" x 1'-2".
5. HEIGHT OF BLOCK NOT TO EXCEED 5FT UNLESS BLOCKING UNDER CENTERLINE KEEL IS CRIBBED.

AECOM

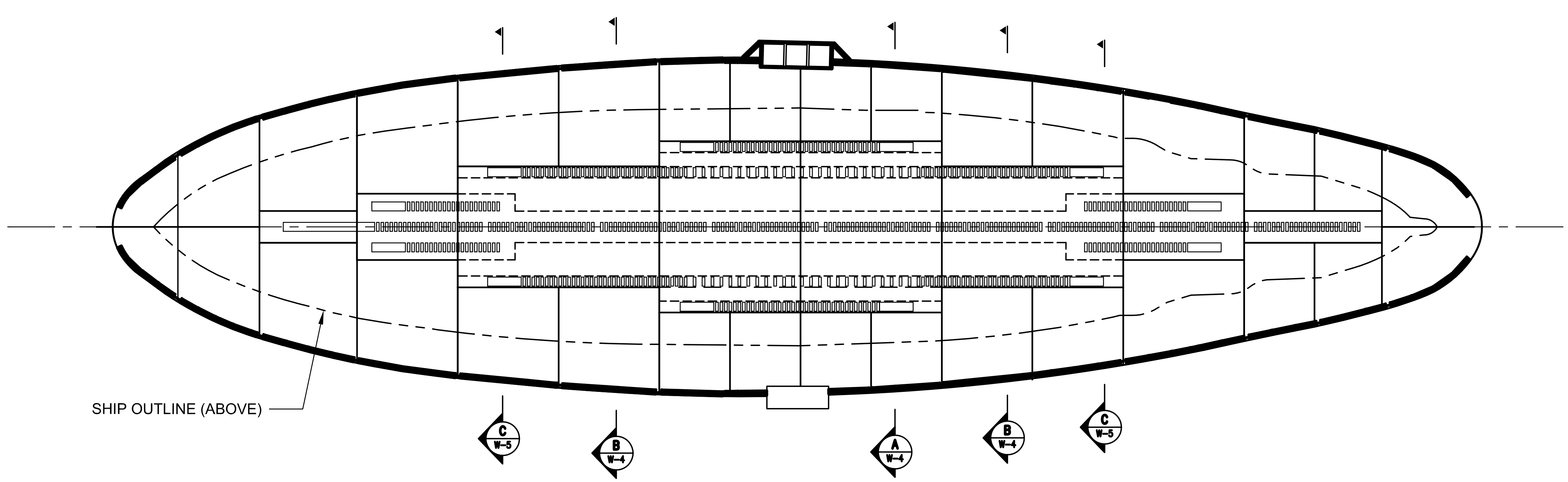
# Figure 4-6: Blocking Plan & Pile and Framing Plan




PILE & FRAMING PLAN

PILE LEGEND:

- ● 300T (3'ø x 120')
- ◒ 250T (3'ø x 105')
- ○ 200T (3ø x 90')




BLOCKING PLAN

GRAPHIC SCALE: 1" = 60'-0"

20'10' 0 20' 40' 60' 80' 100' 200'

TEXAS PARKS & WILDLIFE

AECOM

NOT FOR CONSTRUCTION

BATTLESHIP TEXAS (BB-35)

ALTERNATIVES LA1 1.2.1, 1.3 & 2.2B

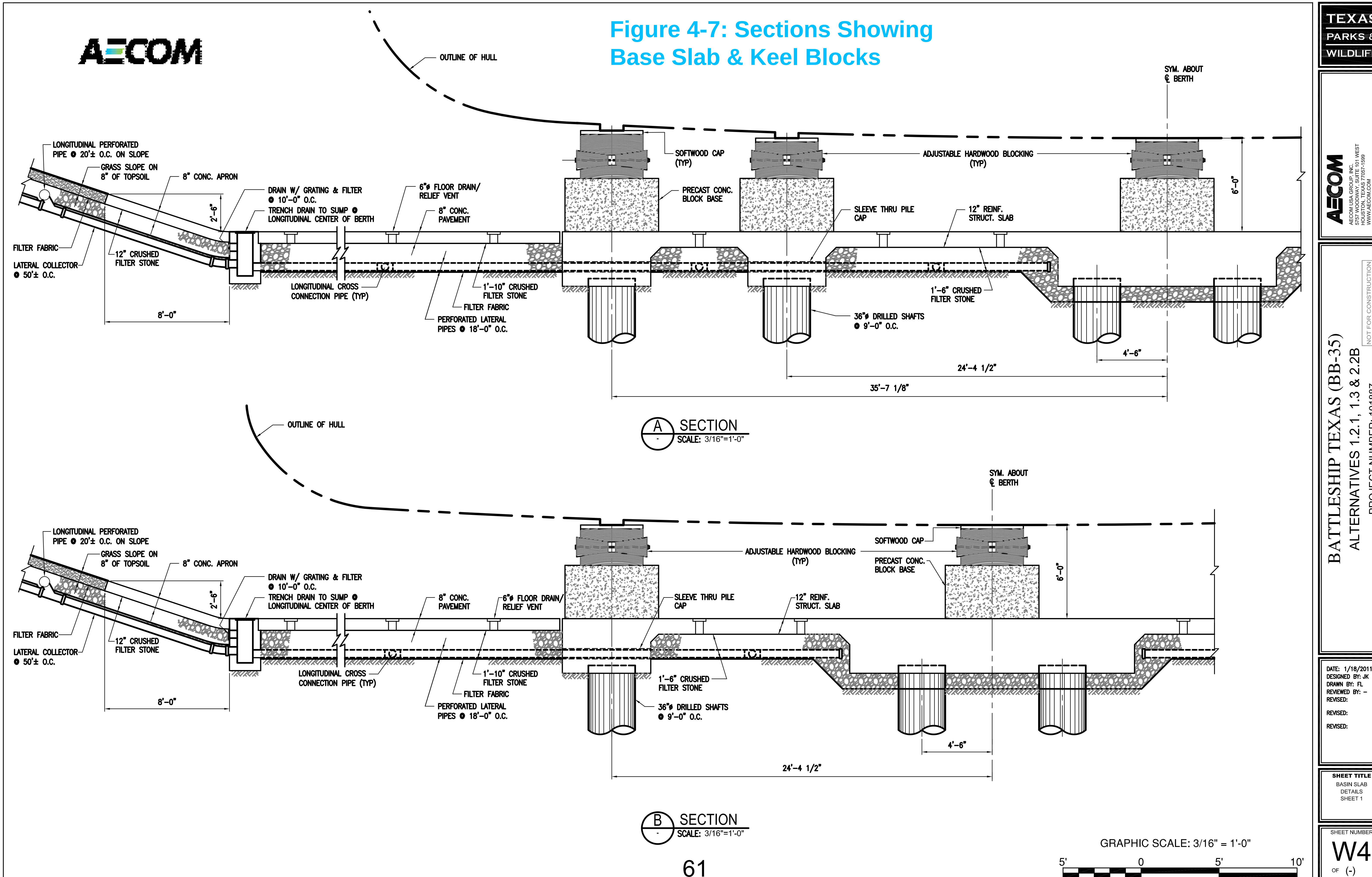
PROJECT NUMBER: 101887

DATE: 7/22/2011
DESIGNED BY: JK
DRAWN BY: FL
REVIEWED BY:
REVISED:
REVISED:
REVISED:

SHEET TITLE
PILES & BLOCKING PLAN

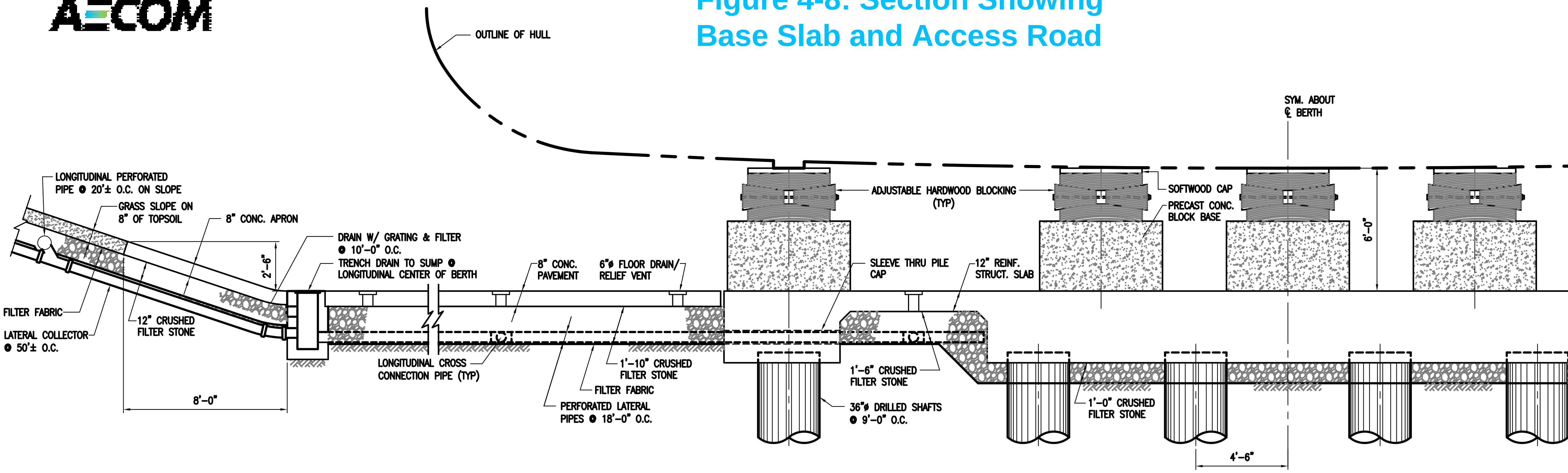
SHEET NUMBER
W7
OF (-)

# Figure 4-7: Sections Showing Base Slab & Keel Blocks

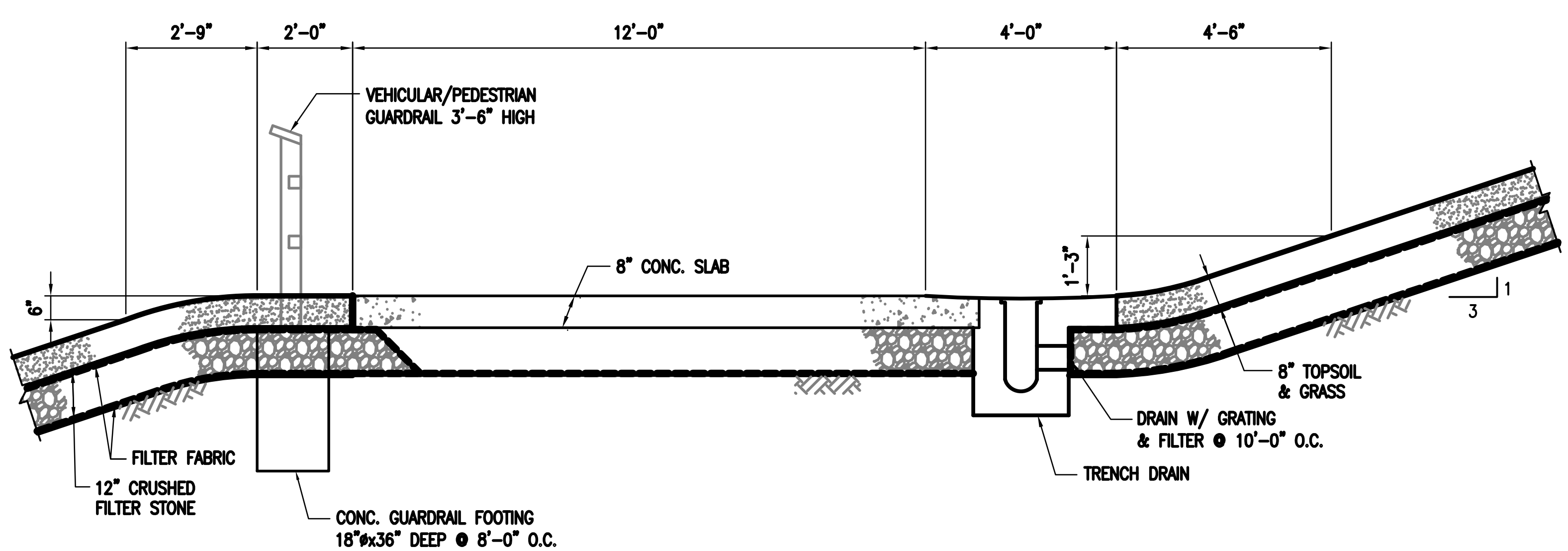


AECOM

# Figure 4-8: Section Showing Base Slab and Access Road




C SECTION
SCALE: 3/16"=1'-0"




TYPICAL ACCESS ROAD SECTION
SCALE: 1/4"=1'-0"

GRAPHIC SCALE: 1/4" = 1'-0"
5' 4' 3' 2' 1' 0 5'

GRAPHIC SCALE: 3/16" = 1'-0"
5' 0 5' 10'

TEXAS PARKS & WILDLIFE

AECOM
AECOM USA GROUP, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TPBE REG. NO. F-3082

NOT FOR CONSTRUCTION

BATTLESHIP TEXAS (BB-35)
ALTERNATIVE LA1 1.2.1, 1.3 & 2.2B
PROJECT NUMBER: 101887

DATE: 1/18/2011
DESIGNED BY: JK
DRAWN BY: FL
REVIEWED BY:
REVISED:
REVISED:
REVISED:

SHEET TITLE
BASIN SLAB DETAILS SHEET 2

SHEET NUMBER
W5
OF (-)

Figure 4-9: Option 1 Rendering View 1

**Figure 4-10: Option 2 Rendering View 1**

Figure 4-11: Option 3 Rendering View 1

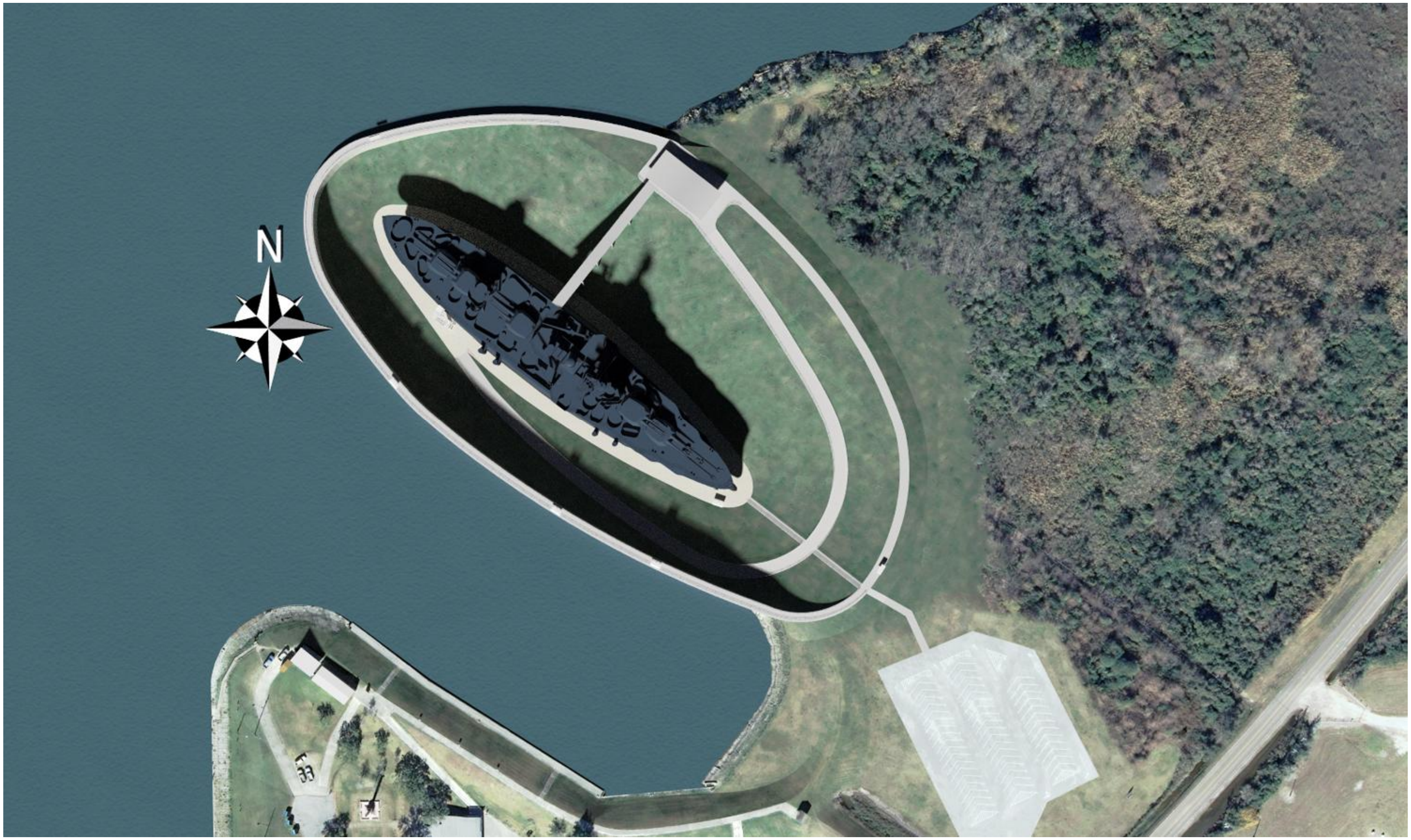
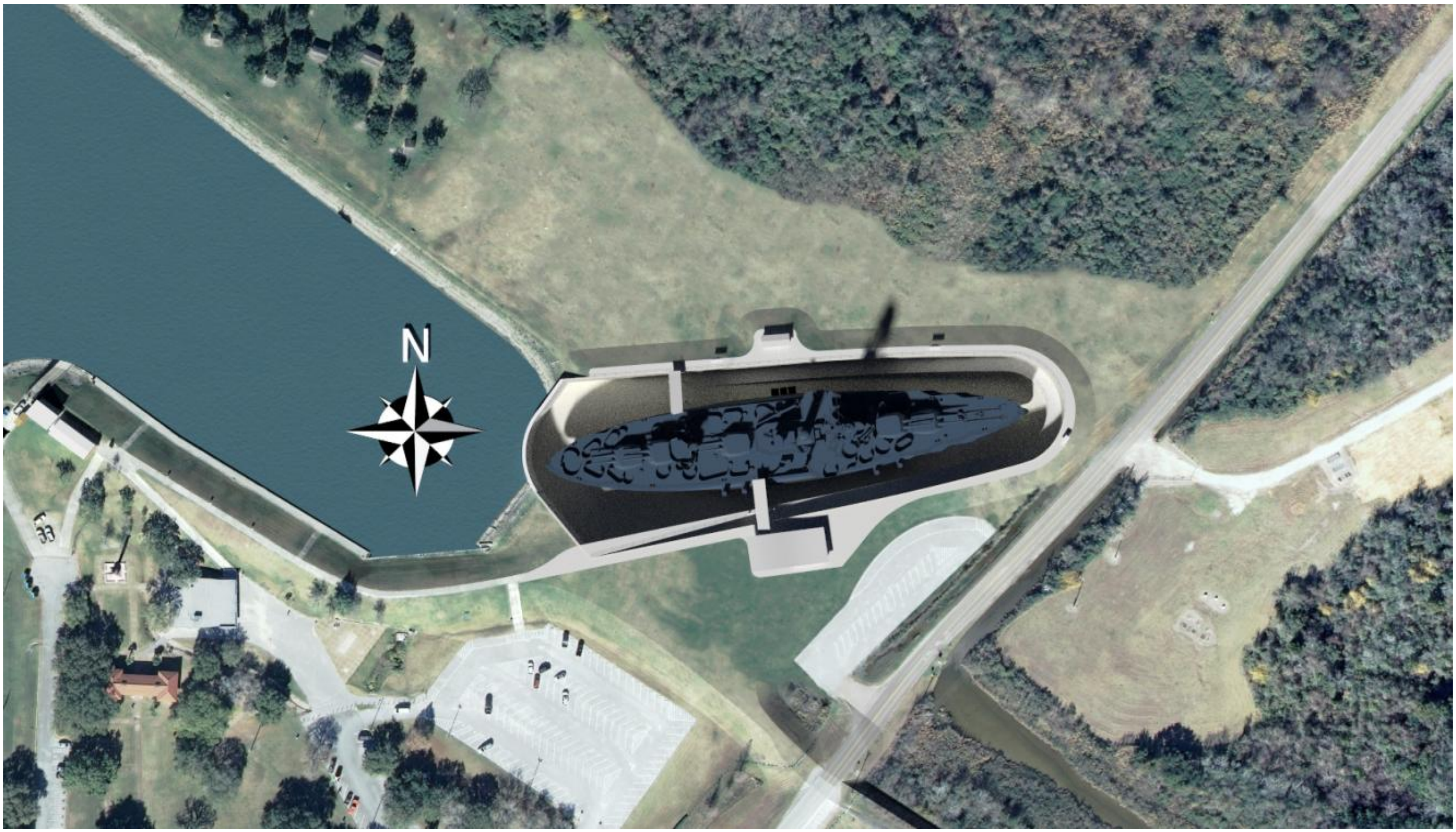


**Figure 4-12: Option 4 Rendering View 1**



# 5 PREPARE CAPITAL AND LIFE CYCLE COST ESTIMATES FOR FOUR OPTIONS

## 5.1 CONSTRUCTION SEQUENCING

This section outlines the construction sequencing assumptions made by the design team for the purpose of estimating costs and evaluating constructability.

Preliminary construction sequencing for the four alternatives is presented herein.

### 5.1.1 ALTERNATIVE 1.2.1 (Option1)

Phase 1 Activities

1. Construction of the western king pile bulkhead, promenade, and retaining wall at elevation +13.0'. Simultaneous construction of the southeastern sheet pile wall to elevation +13.0'.
2. Excavate and/or dredge to required elevation at temporary wet berth. Item is inclusive of movement and storage of dredged material.
3. Construct dike on southwest side of the dry berth basin up to the edge of the anchored sheet pile wall for the temporary wet berth as well as on the north side of the dry berth basin to the edge of the proposed temporary construction ramp for access down into the dry berth basin.
4. Install temporary berthing/mooring dolphins at the temporary wet berth facility.

Phase 2 Activities

1. Super flood the system to an elevation of +12.0' for floating and movement of the ship.
2. Relocate ship to temporary wet berth location southeast of existing location.
3. Construct cantilevered king pile wall to elevation +13.0' to create closed off wet berth storage facility. Item is inclusive of temporary trestles/platforms for installation of the king pile system.

Phase 3 Activities

1. Dewater dry berth basin for installation of auger cast piles and keel block foundation.
2. Construction of temporary construction ramp extending from outside grade elevation (assume approximately +14.0') to bottom of dry berth basin. Item is inclusive of transport of equipment and materials.
3. Installation of auger cast piles, keel block foundation, and relocated mooring monopiles. Item is inclusive of all elements required to support ship when relocated (i.e. precast concrete blocking, hardwood blocking, and softwood caps). Item is also inclusive of all MEP items required for the drainage system under and within the foundation.
4. Construct majority of new dry berth basin slab at elevation -26.0'. Item is inclusive of Drainage Pump Well, MEP required for drainage system, filter fabrics, select fill, etc. Note – Construction of slab will be to the limit of the cantilever king pile wall, remaining slab will be constructed after relocation of ship and dewatering of basin.
5. Installation of dry berth basin access ramp
6. Removal of temporary construction ramp extending from outside grade elevation. Inclusive of removal of all materials and equipment from new dry berth basin.

7. Construction/widening of remaining dike on northeast side of new dry berth basin up to limits of the anchored sheet pile wall for the temporary wet berth facility.

Phase 4 Activities

1. Super flood the western cofferdam for relocation of the ship from the temporary wet berth location.
2. Relocate ship from temporary wet berth location to dry berth location.

Phase 5 Activities

1. Dewater new dry berth basin. Item includes cleaning siltation from the surfaces of the previous construction and from the drainage system.
2. Demolish new cantilever king pile wall and anchored sheet pile wall constructed in Phase 1 for temporary wet berth storage facility. Removal and disposal of temporary berthing/mooring dolphins installed in Phase 1 for temporary wet berth area.
3. Construct remaining portions of basin slab previously blocked by cantilevered king pile wall for temporary wet berth facility.
4. Backfill temporary wet berthing facility to design grade elevation and widen existing dike at locations not previously widened in earlier phases. Assumed that reuse of previously dredged material is acceptable.
5. Installation of new gangway at northeast side of new dry berth basin as detailed on Figure 4-1.

Notes, Clarifications, and Assumptions

1. Note that access will need to be provided during phase 5 for remaining work to be performed as the temporary construction ramp will have been removed.
2. It is assumed that the soil previously excavated will be sufficient for use in backfill at temporary wet berth facility as well as beneath the dry berth revetment

### 5.1.2 ALTERNATIVE 1.3 (Option 2)

Phase 1 Activities

1. Construction of the western king pile bulkhead, promenade, and retaining wall at elevation +13.0'. Simultaneous construction of the southeastern sheet pile wall to elevation +6.0'.
2. Excavate and/or dredge to required elevation at temporary wet berth to elevation -32'. Item is inclusive of movement and storage of dredged material.
3. Construct dike on southwest side of the dry berth basin up to the edge of the anchored sheet pile wall for the temporary wet berth as well as on the north side of the dry berth basin to the edge of the proposed temporary construction ramp for access down into the dry berth basin.
4. Install temporary berthing/mooring dolphins at the temporary wet berth facility.

Phase 2 Activities

1. Flood the system for floating and movement of the ship.
2. Relocate ship to temporary wet berth location southeast of existing location.
3. Construct cantilevered king pile wall to elevation +6.0' to create closed off wet berth storage facility. Item is inclusive of temporary trestles/platforms for installation of the king pile system.

Phase 3 Activities

1. Dewater dry berth basin for installation of auger cast piles and keel block foundation.
2. Construction of temporary construction ramp extending from outside grade elevation (assume approximately +14.0') to bottom of dry berth basin. Item is inclusive of transport of equipment and materials.
3. Installation of auger cast piles, keel block foundation, and relocated mooring monopiles. Item is inclusive of all elements required to support ship when relocated (i.e. precast concrete blocking, hardwood blocking, and softwood caps). Item is also inclusive of all MEP items required for the drainage system under and within the foundation.
4. Construct majority of new dry berth basin slab at elevation -38.0'. Item is inclusive of Drainage Pump Well, MEP required for drainage system, filter fabrics, select fill, etc.
5. Note – Construction of slab will be to the limit of the cantilever king pile wall, remaining slab will be constructed after relocation of ship and dewatering of basin.
6. Installation of dry berth basin access ramp
7. Removal of temporary construction ramp extending from outside grade elevation. Inclusive of removal of all materials and equipment from new dry berth basin.
8. Construction of remaining dike on northeast side of new dry berth basin up to limits of the anchored sheet pile wall for the temporary wet berth facility.

<u>Phase 4 Activities</u>

1. Flood the western cofferdam for relocation of the ship from the temporary wet berth location.
2. Relocate ship from temporary wet berth location to dry berth location.

<u>Phase 5 Activities</u>

1. Dewater new dry berth basin. Item includes cleaning siltation from the surfaces of the previous construction and from the drainage system.
2. Demolish new cantilever king pile wall and anchored sheet pile wall constructed in Phase 1 for temporary wet berth storage facility. Removal and disposal of temporary berthing/mooring dolphins installed in Phase 1 for temporary wet berth area.
3. Construct remaining portions of basin slab previously blocked by cantilevered king pile wall for temporary wet berth facility.
4. Backfill temporary wet berthing facility to design grade elevation and widen existing dike at locations not previously widened in earlier phases. Assumed that reuse of previously dredged material is acceptable.
5. Installation of new gangway at northeast side of new dry berth basin as detailed on drawing W1.3.

<u>Notes, Clarifications, and Assumptions</u>

1. Note that access will need to be provided during phase 5 for remaining work to be performed as the temporary construction ramp will have been removed.
2. It is assumed that the soil previously excavated will be sufficient for use in backfill at temporary wet berth facility as well as beneath the dry berth revetment

### 5.1.3 ALTERNATIVE 2.2 (Option 3)

<u>Phase 1 Activities</u>

1. Construction and installation of the south sheet pile bulkhead
2. Construct temporary sheet pile for basin excavation at west entrance
3. Construct northwest king pile bulkhead from end of temporary sheeting to intersection with land dike
4. Construct dike from south to northwest

Phase 2 Activities

1. Excavation of new dry berth basin area to design grade elevation, to be performed with equipment on the interior of the dry berth basin area in sequencing to allow for excavation to design grade level of -38.0'. Item is inclusive of any dewatering required to facilitate excavation.
2. Preparation of dry berth area to accept equipment and materials.
3. Construct access ramp.
4. Installation of new auger cast piles, keel block foundation and new mooring monopolies. Item is inclusive of all elements required to support ship when relocated (i.e. precast concrete blocking, hardwood blocking, and softwood caps). Item is also inclusive of all MEP items required for the drainage system under and within the foundation. Install new monopiles.
5. Installation of new dry berth basin slab at elevation -38.0'. Items are inclusive of Drainage Pump Well, MEP required for drainage system, filter fabrics, select fill, etc. Item is also inclusive of new pump house, equipment, and controls on north side of new dry berth basin.
6. Perform the staging required for removal of excavation and pile driving equipment remaining in the dry berth basin.

Phase 3 Activities

1. Pump water into dry berth basin area to allow for gradual filling.
2. Perform dredging at west side of new dry berth basin to design dredge elevation of -32.0' to accommodate relocation of ship.
3. Perform dredging at existing ship location for preparation of ship relocation
4. Removal of temporary cofferdam bulkhead previously installed at west entrance. Item is inclusive of required steps to temporarily block new drainage system (if required).
5. Relocation of ship from existing location to new dry berth location.
6. Construction of new permanent breachable closure at west side of new dry berth basin.

Phase 4 Activities

1. Dewater new dry berth basin. Item is inclusive of any cleaning or removal of silts/soils.
2. Construction of main gangway.
3. Finalize any grading and landscaping at dry berth basin.

Phase 5 Activities

1. Widening of dike at perimeter of dry berth basin.
2. Construction of new service building and any remaining upland work.
3. Remove existing monopiles.

Notes, Clarifications, and Assumptions

1. Note that access will need to be provided during phase 5 for remaining work to be performed as the temporary construction ramp will have been removed.

2. It is assumed that the soil previously excavated will be sufficient for use in backfill at temporary wet berth facility as well as beneath the dry berth basin slab.

### 5.1.4 ALTERNATIVE 3.0 (Option 4)

Phase 1 Activities

1. Construction and installation of the temporary structure for equipment access to existing waterway
2. Construction of the temporary cofferdam bulkhead and temporary sheet pile on east side of existing ship to facilitate with outlining dredging limits.

Phase 2 Activities

1. Construction of new perimeter slurry wall and associated promenade at elevation +14.0'.
2. Excavation of new dry berth basin area to design grade elevation. To be performed with equipment on the interior of the dry berth basin area in sequencing to allow for excavation to design grade level of -38.0'. Item is inclusive of any dewatering required to facilitate excavation. Installation of tie-back system to be performed in stages concurrent with excavation.
3. Preparation of dry berth area to accept equipment and materials.
4. Construct access ramp.
5. Installation of new auger cast piles, keel block foundation and new mooring monopolies. Item is inclusive of all elements required to support ship when relocated (i.e. precast concrete blocking, hardwood blocking, and softwood caps). Item is also inclusive of all MEP items required for the drainage system under and within the foundation.
6. Install new monopiles.
   Installation of new dry berth basin slab at elevation -38.0'. Items is inclusive of Drainage
7. Pump Well, MEP required for drainage system, filter fabrics, select fill, etc. Item is also inclusive of new pump house, equipment, and controls on north side of new dry berth basin.
8. Perform the staging required for removal of excavation and pile driving equipment remaining in the dry berth basin.

Phase 3 Activities

1. Pump water into dry berth basin area to allow for gradual filling.
2. Perform remaining dredging at west side of new dry berth basin to design dredge elevation of -32.0' to accommodate relocation of ship.
3. Removal of temporary cofferdam bullhead previously installed. Item is inclusive of required steps to temporarily block new drainage system (if required).
4. Relocation of ship from existing location to new dry berth location.
5. Construction of new permanent breachable closure at west side of new dry berth basin.

Phase 4 Activities

1. Dewater new dry berth basin. Item is inclusive of any cleaning or removal of silts/soils.
2. Construction of main gangway, and auxiliary gangway.
3. Finalize any grading and landscaping at dry berth basin.

Phase 5 Activities

1. Widening of dike at perimeter of dry berth basin.
2. Construction of new service building and any remaining upland work.
3. Remove existing monopiles.

Notes, Clarifications, and Assumptions

1. Note that access will need to be provided during Phase 5 for remaining work to be performed as the temporary construction ramp will have been removed.
2. It is assumed that the soil previously excavated will be sufficient for use in backfill at temporary wet berth facility as well as beneath the dry berth basin slab.
3. Constructor to ensure slurry wall at construction staging and lay down areas can accommodate surcharge from construction loading

## 5.2 CAPITAL COST ESTIMATES

Cost estimates were based on the following assumptions:

1. Calculations including quantity take-off for major elements of the project required to construct the design
2. Cost assumptions for material and equipment
3. Unit cost data
4. Contingency factors
5. Construction cost indices to update costs from data source
6. Use of local cost data where feasible
7. Capital cost estimates exclude TPWD construction management costs
8. Capital cost estimates excludes ship repair costs

Summaries of the capital cost estimates are shown in the following Tables:

- Table 5-1: Capital Cost Summary for Alternatives With Temporary Berth
- Table 5-2: Capital Cost Summary for Alternatives Without Temporary Berth
- Figure 5-1: Capital Cost Summary for Alternatives With Temporary Berth
- Figure 5-2: Capital Cost Summary for Alternatives Without Temporary Berth

Detailed capital cost estimates for dry berth Options 1 to 4 are shown in Tables 5-6 to 5-10.

## 5.3 LIFE CYCLE COST ANALYSIS

The life cycle cost analysis was based on a set of assumptions which are shown in Table5-3. The results of the life cycle analysis are also shown in the same Table.

## 5.4 COST OF DRY DOCKING

The following assumptions were made in order to estimate the cost of drydocking for the TEXAS:

- TEXAS could be towed to Galveston Gulf Copper yard for repairs which is an unlikely scenario considering the result of the ship survey and the stability analysis report
- 40% of the repair works will be done during the initial drydocking
- 30% of the repair works will be done during 15 years
- 30% of the repair works will be done during 30 years

- Duration of first  drydocking was assumed of 150 days
- Duration of subsequent drydocking was assumed to be 100 days
- Cost escalation was assumed to be 5% per year
- Discount rate at 4%

The NPV (Net Present Value) of the cost of drydocking is shown in following Table 5-4.

## 5.5 COST COMPARISON OF DRY BERTH OPTIONS AND DRYDOCKING

A cost comparison of the capital and life cycle cost for the dry berth options vs. the cost of drydocking the TEXAS every 15 years without contingencies is shown in Table 5-5. Assuming that the TEXAS could be towed which is unlikely based on the hull survey inspection report, the Naval Architect report and the risks associated with towing, the dry berth construction is considered a superior economic option.

**Table 5-1: Capital Cost Summary of Alternatives with Temporary Berth**

| ITEMS/ALTERNATIVES | AECOM Loaded[1] 2011 Costs w/ Temp Wet Berth | | | |
|---|---|---|---|---|
| | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 |
| 1.0 - Dredging/Removals | $1,354,000 | $4,540,000 | $6,326,000 | $3,225,000 |
| 2.0 - Dry Berth Wall | $7,207,000 | $9,949,000 | $14,555,000 | $23,105,000 |
| 3.0 - Dry Berth Slab | $6,325,000 | $6,356,000 | $6,320,000 | $7,052,000 |
| 4.0 - Dewat./Drain. Syst. | $760,000 | $738,000 | $728,000 | $768,000 |
| 5.0 - Site Improvement | $831,000 | $919,000 | $1,352,000 | $1,277,000 |
| 6.0 - Temp Wet Berth | $10,501,000 | $10,657,000 | $0 | $0 |
| 7.0 - Ship Relocation | $776,000 | $751,000 | $670,000 | $707,000 |
| 8.0 - Gen.Proj.Mob. | $1,200,000 | $1,200,000 | $1,200,000 | $1,200,000 |
| Construction Contingency @ 20% | $5,790,800 | $7,022,000 | $6,230,200 | $7,466,800 |
| Eng., Geotech Testing, CM @ 10% | $3,474,480 | $4,213,200 | $3,738,120 | $4,480,080 |
| Totals | $38,219,280 | $46,345,200 | $41,119,320 | $49,280,880 |
| Note 1: Items 1 to 8 Include General Contractor Supervision ,OH & Profit of 20% | | | | |

**Table 5-2: Capital Cost Estimate of Alternatives without Temporary Berth**

| ITEMS/ALTERNATIVES | AECOM Loaded[1] 2011 Costs w/o Temp Wet Berth | | | |
|---|---|---|---|---|
| | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 |
| 1.0 - Dredging/Removals | $792,000 | $3,654,000 | $6,326,000 | $3,225,000 |
| 2.0 - Dry Berth Wall | $7,207,000 | $9,949,000 | $14,555,000 | $23,105,000 |
| 3.0 - Dry Berth Slab | $6,325,000 | $6,356,000 | $6,320,000 | $7,052,000 |
| 4.0 - Dewat./Drain. Syst. | $760,000 | $738,000 | $728,000 | $768,000 |
| 5.0 - Site Improvement | $831,000 | $919,000 | $1,352,000 | $1,277,000 |
| 7.0 - Ship Relocation | $776,000 | $751,000 | $670,000 | $707,000 |
| 8.0 - Gen.Proj.Mob. | $1,200,000 | $1,200,000 | $1,200,000 | $1,200,000 |
| Construction Contingency @ 20% | $3,578,200 | $4,713,400 | $6,230,200 | $7,466,800 |
| Eng., Geotech Testing, CM @ 10% | $2,146,920 | $2,828,040 | $3,738,120 | $4,480,080 |
| Totals | $23,616,120 | $31,108,440 | $41,119,320 | $49,280,880 |
| Note 1: Items 1 to 8 Include General Contractor Supervision ,OH & Profit of 20% | | | | |

**Figure 5-1: Dry Berth Options Capital Cost**

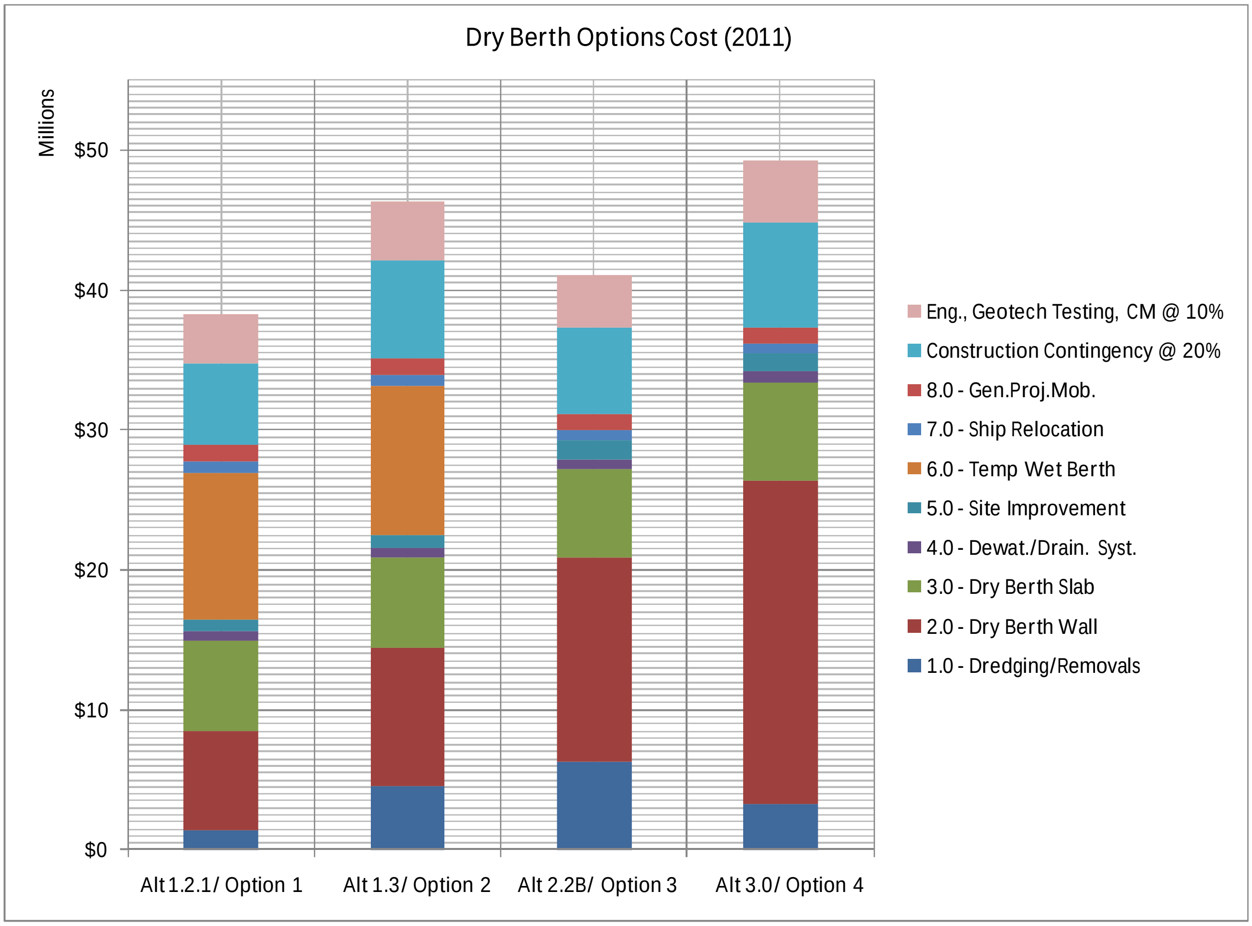
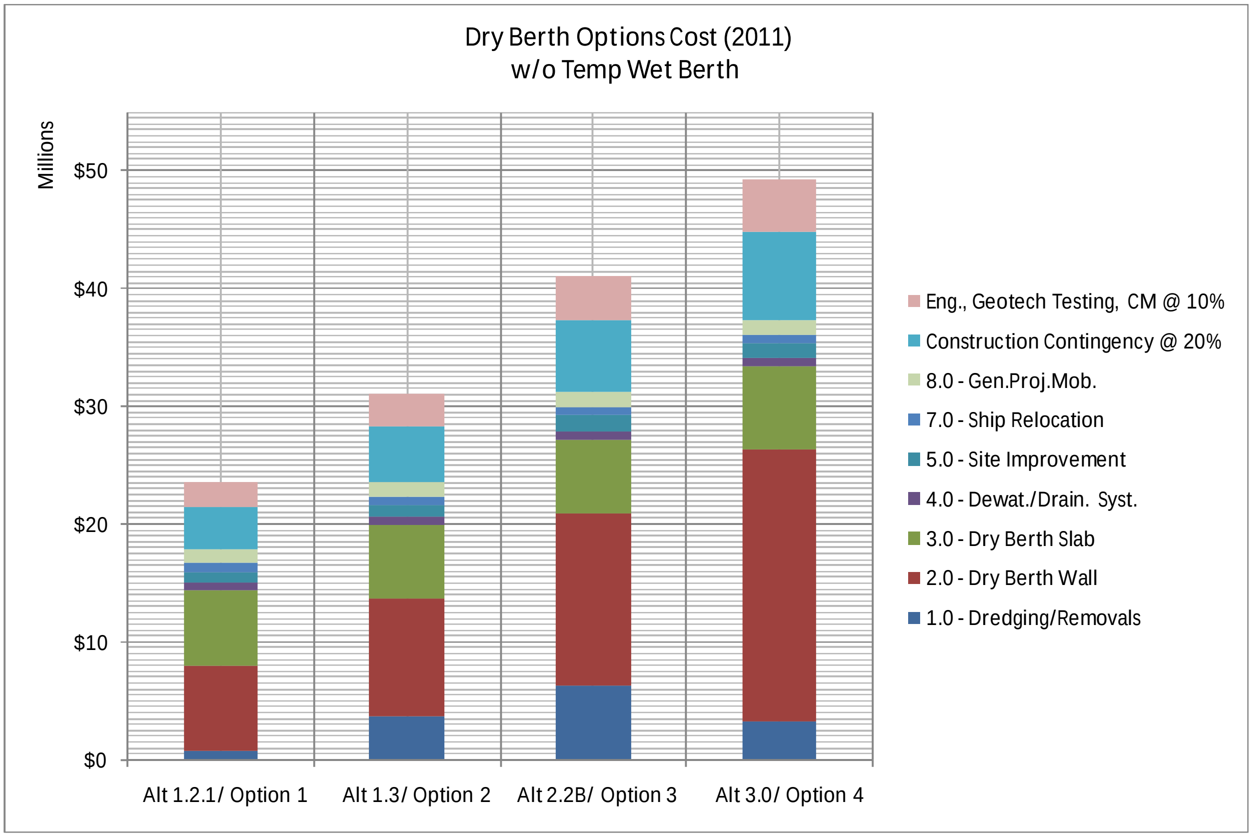


**Figure 5-2: Dry Berth Options Capital Cost Without Temporary Berth**



### Table 5-3: Summary of Life Cycle Costs for Alternatives

| Life Cycle Costs Assumptions-30 Years | | | | | | |
|---|---|---|---|---|---|---|
| Item | Factor | Frequency (Yrs) | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 |
| Escalation (%) | 5% | 1 | | | | |
| Discount Rate (%) | 4% | 1 | | | | |
| Dry Berth Wall (Steel) | | | | | | |
| Capital Cost of CP(Cathodic Protection) | 6% of Wall | | | | | |
| CP Power | 6% of CP | 1 | $672,000 | $1,018,000 | $1,770,000 | $524,000 |
| CP Inspection | 3% of CP | 1 | $336,000 | $509,000 | $885,000 | $262,000 |
| Anode Replacement | 50% of CP | 15 | $381,000 | $577,000 | $1,002,000 | $296,000 |
| Periodic Structural Inspection | 1% of Wall | 5 | $399,000 | $604,000 | $1,051,000 | $311,000 |
| Maintenance Cost | 3% of Wall | 5 | $1,142,000 | $1,730,000 | $3,007,000 | $888,000 |
| Dry Berth Slab Maintenance | 0.5% | 1 | $698,000 | $702,000 | $698,000 | $779,000 |
| Drain Dewater System | 8% | 1 | $2,804,000 | $2,720,000 | $2,685,000 | $2,832,000 |
| Landscaping | 8% | 1 | $1,564,000 | $1,997,000 | $1,400,000 | $0 |
| Total Estimated Life Cycle Costs | | | $7,996,000 | $9,857,000 | $12,498,000 | $5,892,000 |

### Table 5-4: Cost of Drydocking

| NET PRESENT VALUE OF DRYDOCKING THE TEXAS (W/O CONTINGENCIES) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 5% | | 4.0% | |
| DRYDOCKING | Year | Cost | Contin-gencies | Cost w/o Contingencies | Escalation Factor | Cost w/ Escalation | Discount Factor | NPV |
| INITIAL | 0 | $38,079,075 | 0% | $38,079,075 | 1.00 | $38,079,075 | 1.00 | $38,079,075 |
| 2ND DRYDOCKING-15 YEARS | 15 | $27,804,550 | 0% | $27,804,550 | 2.08 | $57,803,663 | 1.80 | $32,096,322 |
| 3RD DRYDOCKING-30 YEARS | 30 | $27,804,550 | 0% | $27,804,550 | 4.32 | $120,169,663 | 3.24 | $37,050,550 |
| | | | | $93,688,175 | | | | $107,225,947 |
| NET PRESENT VALUE OF DRYDOCKING THE TEXAS (W/ CONTINGENCIES) | | | | | | | | |
| | | | | | 5% | | 3.5% | |
| DRYDOCKING | Year | COST | Contin-gencies | Cost w/ Contingencies | Escalation Factor | Cost w/ Escalation | Discount Factor | NPV |
| INITIAL | 0 | $38,079,075 | 20% | $45,694,890 | 1.00 | $45,694,890 | 1.00 | $45,694,890 |
| 2ND DRYDOCKING-15 YEARS | 15 | $27,804,550 | 20% | $33,365,460 | 2.08 | $69,364,395 | 1.80 | $38,515,586 |
| 3RD DRYDOCKING-30 YEARS | 30 | $27,804,550 | 20% | $33,365,460 | 4.32 | $144,203,595 | 3.24 | $44,460,660 |
| | | | | $112,425,810 | | | | $128,671,137 |

Note: Detailed estimates for the cost of drydocking are shown in Table 5-10.

### Table 5-5: Comparison of Dry Berth Options and Drydocking Costs

| Cost | Alt 1.2.1/ Option 1 | Alt 1.3/ Option 2 | Alt 2.2B/ Option 3 | Alt 3.0/ Option 4 | Drydocking (NPV) w/o Contingencies |
|---|---|---|---|---|---|
| Capital Cost | $38,219,280 | $46,345,200 | $41,119,320 | $49,280,880 | |
| Life Cycle Costs | $7,996,000 | $9,857,000 | $12,498,000 | $5,892,000 | |
| Total Costs | $46,215,280 | $56,202,200 | $53,617,320 | $55,172,880 | $107,226,000 |

# Table 5-6: Detailed Cost Estimate- Option 1

Alternative 1.2.1 (Option 1)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1.0 | Dredging and Removals: | | | | | |
| 1.1 | Remove revetment armoring | SF | 30240 | $6.48 | $195,948 | 960 LF x 31.5' wide |
| 1.2 | Remove existing gangway | LS | 1 | $5,000.00 | $5,000 | |
| 1.3 | Dredging mobilization/demobilization | LS | 1 | $50,000.00 | $50,000 | Assume all Mechanical Dredging |
| 1.4 | Dredging for wet berth formation | CY | 0 | $0.00 | $0 | All excavation can be done after dewatering. |
| 1.5 | Dredging for ship move | CY | 0 | $0.00 | $0 | Avoided by superflooding |
| 1.6 | Dredging for dry berth basin formation | CY | 0 | $0.00 | $0 | Avoided by use of landside equipment |
| 1.7 | Dredge placement fee and testing | CY | 0 | $0.00 | $0 | Not required, assume mechanical dredging |
| 1.8 | Pipeline | LS | 0 | $0.00 | $0 | Not required, assume mechanical dredging |
| 1.9 | Temporary Platform for Marine Access (temp wall removal) | LS | 1 | $250,000.00 | $250,000 | |
| 1.10 | Excavation in dry for basin formation, after dewatering | CY | 34711 | $6.50 | $225,622 | Stockpile suitable material for use as fill |
| 1.11 | Excavation in dry for wet berth formation | CY | 60022 | $6.50 | $390,143 | Stockpile suitable material for use as fill |
| 1.12 | Disposed unused excavated fill | CY | 2966 | $4.00 | $11,864 | Assumed disposal on TPWD site |
| | 1.0 Total | | | | $1,128,577 | |
| 2.0 | Dry Berth Wall Construction: | | | | | |
| 2.1 | King pile cantilever cofferdam | | | | | |
| 2.1.1 | Wall - Type 1 | LF | 145 | $9,187.00 | $1,332,115 | Zone G & F'; 9,477 lbs/ft - Halcrow Note: Wall type in description does not match wall type in bulkhead descriptions; Halcrow assumes a TYPE 2 WALL |
| 2.1.2 | Wall - Type 2 | LF | 165 | $6,852.00 | $1,130,580 | Zone F; 6910 lbs/ft - Halcrow Note: Wall type in description does not match wall type in bulkhead descriptions; Halcrow assumes a TYPE 1 WALL |
| 2.1.3 | Wall - Type 3 | LF | 200 | $4,575.00 | $915,000 | Zone E & E'; 4397 lbs/ft - Halcrow Note: Wall type in description does not match wall type in bulkhead descriptions; Halcrow assumes a TYPE 1 WALL |
| 2.1.4 | Promenade on top of wall | LF | 530 | $460.00 | $243,800 | Assume 12 feet wide conc. deck with guard rails each side |
| 2.2 | Fill | CY | 33224 | $6.00 | $199,344 | Could use stockpiled excavated material |
| 2.3 | Access ramp on grade | | | | | |
| 2.3.1 | Paving | SF | 10440 | $10.00 | $104,400 | 870 LF x 12' wide; assume 10" thick concrete |
| 2.3.2 | Trench drain | LF | 850 | $180.00 | $153,000 | |
| 2.3.3 | Guard rails | LF | 870 | $40.00 | $34,800 | |
| 2.4 | Landscaping | | | | $0 | |
| 2.4.1 | Topsoil | SF | 235805 | $0.63 | $147,378 | Assume 8" thick |
| 2.4.2 | Grass | SF | 235805 | $1.50 | $353,708 | Bermuda grass |
| 2.4.3 | Concrete paved apron at toe of slope | SF | 11052 | $5.50 | $60,786 | Assume 8" thick |
| 2.4.4 | Filter stone | CY | 7800 | $66.00 | $514,800 | |
| 2.4.5 | Filter fabric | SF | 420000 | $0.50 | $210,000 | |
| 2.4.6 | Egress Stairway up slope | LF | 150 | $200.00 | $30,000 | Concrete staircase, assume 6' wide w/handrails ea side |
| 2.5 | Underdrain perforated piping | LF | 15000 | $4.50 | $67,500 | Assume 4" PVC pipe wrapped in filter fabric |
| 2.6 | Cleanouts for underdrains | Each | 250 | $300.00 | $75,000 | |
| 2.7 | Dike | | | | | |
| 2.7.1 | Fill | CY | 712 | $6.00 | $4,272 | For berm widening; new berms included in Item 2.2 |
| 2.7.2 | Paving | SF | 14280 | $10.00 | $142,800 | New berms 1030 ft long @ 12' wide; widening 480' @ 4' |
| 2.8 | Temporary dewatering system for construction | | | | | |
| 2.8.1 | Supply wellpoint system and pumps | LS | 1 | | $200,000 | |
| 2.8.2 | Dewater dry berth basin for construction | LS | 1 | $46,375.00 | $46,375 | Assume basin volume = 54,000,000 gallons (understood that volume will be less than final dry berth basin, taken to be conservative). |
| 2.8.3 | Maintain dry basin | Months | | | $40,000 | |
| | 2.0 Total | | | | $6,005,658 | |
| 3.0 | Dry Berth Slab Construction: | | | | | |
| 3.1 | Piles | | | | | |
| 3.1.1 | 36" concrete piles, 300t (120' lg) | Each | 34 | $13,670.00 | $464,780 | |
| 3.1.2 | 36" concrete piles, 250t (105' lg) | Each | 78 | $12,045.00 | $939,510 | |
| 3.1.3 | 36" concrete piles, 200t (90' lg) | Each | 128 | $10,475.00 | $1,340,800 | |
| 3.2 | Pile caps | CY | 1293 | $425.00 | $549,525 | |
| 3.3 | Structural slab | CY | 873 | $375.00 | $327,375 | |
| 3.4 | Pavement slab | SF | 49123 | $10.50 | $515,792 | Assume 8" thick |
| 3.5 | Filter stone | CY | 4185 | $66.00 | $276,210 | |
| 3.6 | Filter fabric | SF | 67256 | $0.50 | $33,628 | |
| 3.7 | Underdrain piping | LF | 5900 | $9.00 | $53,100 | assume 4" perforated PVC wrapped in fabric |
| 3.8 | Floor drains/relief vents | Each | 464 | $150.00 | $69,600 | |
| 3.9 | Perimeter trench drain | LF | 1200 | $180.00 | $216,000 | |
| 3.10 | Cleanouts for underdrains | Each | 94 | $300.00 | $28,200 | |
| 3.11 | Keel Blocks | | | | | |
| 3.11.1 | Precast concrete bases | Each | 150 | $1,200.00 | $180,000 | Assume 6' wide x 3.5' high x 5.83' long |
| 3.11.2 | Timber blocking: Hardwood | MBF | 15 | $3,600.00 | $54,000 | |
| 3.11.3 | Timber blocking: Softwood caps | MBF | 108 | $1,500.00 | $162,000 | |
| 3.12 | Temporary Construction Access Ramp | 1 | LS | $60,000.00 | $60,000 | |
| | 3.0 Total | | | | $5,270,520 | |
| | | | | | | |

# Table 5-6: Detailed Cost Estimate-Option 1 (Cont'd)

Alternative 1.2.1 (Option 1)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| 4.0 | Dewatering/Drainage System: | | | | | |
| 4.1 | Pumpwell: | | | | | |
| 4.1.1 | Floor | CY | 28 | $400.00 | $11,200 | |
| 4.1.2 | Walls | CY | 176 | $400.00 | $70,400 | |
| 4.1.3 | Roof framing/grating | SF | 257 | $50.00 | $12,850 | |
| 4.2 | Submersible pumps, 8,500 gpm w/ controls | Each | 3 | $103,000.00 | $309,000 | |
| 4.3 | Cross culverts, 24" | LF | 310 | $90.00 | $27,900 | Connect south side trench drains to north side pumpwell |
| 4.4 | Pipes to valve chamber, 18" | LF | 420 | $50.00 | $21,000 | Connect pumps to valve chamber in service bldg |
| 4.5 | Valves | LS | 1 | | $0 | |
| 4.6 | Valves/Valve chamber | LS | 1 | | $116,000 | 1-30" gate valve; 1 - 30" Tideflex valve; 3-18" plug valves; 3-18" check valves; 4 air release valves |
| 4.7 | Valve controls | LS | 1 | | $20,000 | |
| 4.8 | Pump controls | LS | 1 | | $0 | |
| 4.9 | Outfall force main, 30" | LF | 315 | $80.00 | $25,200 | |
| 4.10 | Outfall structure | LS | 1 | | $20,000 | |
| | 4.0 Total | | | | $633,550 | |
| 5.0 | Site Improvements: | | | | | |
| 5.1 | Move monopiles | | | | | |
| 5.1.1 | Extract monopiles | Each | 4 | $5,000.00 | $20,000 | |
| 5.1.2 | Re-install monopiles | Each | 4 | $8,000.00 | $32,000 | |
| 5.2 | Gangways | | | | | One gangway, north side; 155' long |
| 5.2.1 | Piles | LF | 980 | $105.00 | $102,900 | Assume 14 piles 70' long - Note: Assume 24" Concrete Pile |
| 5.2.2 | Pile Caps | CY | 38 | $450.00 | $17,100 | Assume 7 support bents |
| 5.2.3 | Spans | SF | 2480 | $35.00 | $86,800 | Assume 6 spans - Note: Assume Precast, Pre-stressed with topping slab. |
| 5.2.4 | Guardrails | LF | 310 | $40.00 | $12,400 | Note: Assume standard FDOT Guardrail |
| 5.3 | Redirect twin 16" drain pipes to channel | LF | 1300 | $34.00 | $44,200 | 650' from SE corner of basin to channel - Note: Assume Installation of New Standard FDOT 0430175118 Pipe |
| 5.4 | Redirect 24" culvert to channel | LF | 1100 | $90.00 | $99,000 | 1100' from west side of basin to channel - Note: Assume Installation of New Standard FDOT 0430174124 Culvert |
| 5.5 | Relocate primary electrical ship service | LS | 1 | | $168,000 | |
| 5.6 | Relocate ship water service | LS | 1 | | $60,000 | |
| 5.7 | Relocate ship wastewater service | LS | 1 | | | |
| 5.8 | Secondary Egress Staircase | LS | 1 | $50,000.00 | $50,000 | South side of ship, from ship deck to basin slab. Standard steel framed stack with intermediate landings in a scissors arrangement, concrete-filled treads 4' wide, overall height of 61'. |
| | 5.0 Total | | | | $692,400 | |
| 6.0 | Temporary Wet Berth: | | | | | |
| 6.1 | Wall Sheeting | LF | 915 | $2,400.00 | $2,196,000 | Zones A&B; 2526 lbs/ft |
| 6.2 | Wall Anchors | Each | 148 | $1,000.00 | $148,000 | 1.375" dia Grade 75 threadbar, 47' long - Halcrow Note: Inclusive of Tie-Rod, Plates, and Walers. |
| 6.3 | King pile side walls | LF | 375 | $9,740.00 | $3,652,500 | Zone D; 10,173 lbs/ft - Halcrow Note: Assume Type 2 Wall |
| 6.4 | King pile closure wall | LF | 155 | $9,740.00 | $1,509,700 | Zone C; 10,173 lbs/ft - Halcrow Note: Assume Type 2 Wall |
| 6.5 | Mooring Monopiles | Each | 4 | $160,000.00 | $640,000 | Halcrow Note: Assume Large Pipe with Donut Fender |
| 6.6 | Pumping system to maintain water level | LS | 1 | | $100,000 | |
| 6.7 | Pumping system operation | months | | | $72,000 | |
| 6.8 | Backfill wet berth after dry berthing ship | CY | 57831 | $6.00 | $346,986 | Could use stockpiled excavated material |
| 6.9 | Features to maintain visitor ship access: | | | | | |
| 6.9.1 | Temporary Gangway & stair tower | Each | 1 | $35,750.00 | $35,750 | Note: Assume $225/lf @ 70' for gangway, $20,000 allowance for stair tower. |
| 6.9.2 | Temporary electric power | LS | 1 | | $30,000 | |
| 6.9.3 | Temporary water supply | LS | 1 | | $20,000 | |
| 6.9.4 | Temporary wastewater line | LS | 1 | | | |
| | 6.0 Total | | | | $8,750,936 | |
| 7.0 | Move Ship | | | | | |
| 7.1 | Temporary mooring fixtures/winches | LS | 1 | $280,100.00 | $280,100 | |
| 7.2 | Flood dry berth | Cycles | 1 | $46,375.00 | $46,375 | Basin Volume = 54,000,000 gallons |
| 7.3 | Move ship to dry berth | LS | 1 | $50,000.00 | $50,000 | |
| 7.4 | Dewater dry berth | Cycles | 1 | $55,650.00 | $55,650 | Basin Volume = 54,000,000 gallons |
| 7.5 | Extract sheeting after dry berthing ship | LF | 1445 | $100.00 | $144,500 | May have scrap value for reuse. |
| 7.6 | Move ship to wet berth | LS | 1 | $50,000.00 | $50,000 | |
| 7.7 | Superflood dry berth | Cycles | 2 | $6,625.00 | $13,250 | Assume volume = 5,000,000 gallons required |
| 7.8 | Superflood wet berth | Cycles | 1 | $6,625.00 | $6,625 | Assume volume = 5,000,000 gallons required |
| | 7.0 Total | | | | $646,500 | |
| | General Project Mobilization | LS | 1 | $1,000,000 | $1,000,000 | |
| | SUB TOTAL | | | | $24,128,000 | |
| | Supervision, OH & P - 20% | | | | $4,825,600 | |
| | TOTAL COST | | | | $28,953,600 | |
| | Construction Contingency - 20% | | | | $5,791,000 | |
| | Engineering, Geotech Testing, CM -10% | | | | $3,474,460 | |
| | FINAL COST | | | | $38,219,000 | |

# Table 5-7: Detailed Cost Estimate- Option 2

Alternative 1.3 (Option 2)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| 1.0 | Dredging and Removals: | | | | | |
| 1.1 | Remove revetment armoring | SF | 30240 | $6.48 | $195,955 | 900 LF x 31.5' wide |
| 1.2 | Remove existing gangway | LS | 1 | $5,000.00 | $5,000 | |
| 1.3 | Dredging mobilization/demobilization | LS | 1 | $200,000.00 | $200,000 | Assumed hydraulic dredging required at areas. |
| 1.4 | Dredging for wet berth formation | CY | 0 | $0.00 | $0 | Done using landside equipment; included in Item 1.11 |
| 1.5 | Dredging for ship move | CY | 72900 | $12.00 | $874,800 | |
| 1.6 | Dredging for dry berth basin formation | CY | 0 | $0.00 | $0 | |
| 1.7 | Dredge placement fee and testing | CY | 72900 | $10.00 | $729,000 | |
| 1.8 | Pipeline | LS | 1 | $200,000.00 | $200,000 | |
| 1.9 | Excavation in dry for basin formation, after dewatering | CY | 75200 | $6.50 | $488,800 | Stockpile suitable material for use as fill |
| 1.10 | Temporary Platform for Marine Access | LS | 1 | $250,000.00 | $250,000 | Needed for removal of temp wet berth wall |
| 1.11 | Excavation in dry for wet berth formation | CY | 94719 | $6.50 | $615,674 | Stockpile suitable material for use as fill |
| 1.12 | Disposed unused excavated fill | CY | 56048 | $4.00 | $224,192 | Assumed disposal on TPWD site |
| | 1.0 Total | | | | $3,783,421 | |
| 2.0 | Dry Berth Wall Construction: | | | | | |
| 2.1 | King pile cantilever cofferdam | | | | | |
| 2.1.1 | Wall - Type 1 | LF | 288 | $9,571.00 | $2,756,448 | Zones E and E'; 9876 lbs/ft - Halcrow Note: Wall type in description does not match wall type in bulkhead descriptions; Halcrow assumes a TYPE 2 WALL |
| 2.1.2 | Wall - Type 2 | LF | 193 | $10,265.00 | $1,981,145 | Zone G; 10647 lbs/ft |
| 2.1.3 | Wall - Type 3 | LF | 95 | $3,980.00 | $378,100 | Zone F; 3885 lbs/ft, AZ 50 sheeting, no king piles - Note: There is no wall type for this wall in the bulkhead description document, will assume bulkhead description document is correct, not Item Description. |
| 2.1.4 | Promenade on top of wall | LF | 550 | $460.00 | $253,000 | Assume 12 feet wide conc. deck with guard rails each side |
| 2.2 | Fill | CY | 30400 | $6.00 | $182,400 | Could use stockpiled excavated material |
| 2.3 | Access ramp on grade | | | | | |
| 2.3.1 | Paving | SF | 13200 | $10.00 | $132,000 | 1100 LF x 12' wide; assume 10" thick concrete |
| 2.3.2 | Trench drain | LF | 1020 | $180.00 | $183,600 | |
| 2.3.3 | Guard rails | LF | 1100 | $40.00 | $44,000 | |
| 2.4 | Landscaping | | | | | |
| 2.4.1 | Topsoil | SF | 300982 | $0.63 | $188,114 | |
| 2.4.2 | Grass | SF | 300982 | $1.50 | $451,473 | Bermuda grass |
| 2.4.3 | Concrete paved apron at toe of slope | SF | 11035 | $5.50 | $60,693 | Assume 8" thick |
| 2.4.4 | Filter stone | CY | 10300 | $66.00 | $679,800 | |
| 2.4.5 | Filter fabric | SF | 557000 | $0.50 | $278,500 | |
| 2.4.6 | Egress Stairway up slope | LF | 180 | $200.00 | $36,000 | Concrete staircase, 52' rise, 6' wide w/handrails ea side |
| 2.5 | Underdrain perforated piping | LF | 19500 | $4.50 | $87,750 | |
| 2.6 | Cleanouts for underdrains | Each | 325 | $300.00 | $97,500 | |
| 2.7 | Dike | | | | | |
| 2.7.1 | Fill | CY | 771 | $6.00 | $4,626 | For berm widening; new berms included in Item 2.2 |
| 2.7.2 | Paving | SF | 14920 | $10.00 | $149,200 | New berms 1070 ft long @ 12' wide; widening 520' @ 4' |
| 2.8 | Temporary dewatering system for construction | | | | | |
| 2.8.1 | Supply wellpoint system and pumps | LS | 1 | | $250,000 | |
| 2.8.2 | Dewater dry berth basin for construction | LS | 1 | $46,375.00 | $46,375 | Assume basin volume = 52,000,000 gallons (understood that actual volume will be less, taken to be conservative). |
| 2.8.3 | Maintain dry basin | Months | | | $50,000 | |
| | 2.0 Total | | | | $8,290,723 | |
| 3.0 | Dry Berth Slab Construction: | | | | | |
| 3.1 | Piles | | | | | |
| 3.1.1 | 36" concrete piles, 300t (120' lg) | Each | 34 | $13,670.00 | $464,780 | |
| 3.1.2 | 36" concrete piles, 250t (105' lg) | Each | 78 | $12,045.00 | $939,510 | |
| 3.1.3 | 36" concrete piles, 200t (90' lg) | Each | 128 | $10,475.00 | $1,340,800 | |
| 3.2 | Pile caps | CY | 1293 | $425.00 | $549,525 | |
| 3.3 | Structural slab | CY | 873 | $375.00 | $327,375 | |
| 3.4 | Pavement slab | SF | 48874 | $10.50 | $513,177 | |
| 3.5 | Filter stone | CY | 4168 | $66.00 | $275,088 | |
| 3.6 | Filter fabric | SF | 67007 | $0.50 | $33,504 | |
| 3.7 | Underdrain piping | LF | 5900 | $9.00 | $53,100 | |
| 3.8 | Floor drains/relief vents | Each | 464 | $150.00 | $69,600 | |
| 3.9 | Perimeter trench drain | LF | 1200 | $180.00 | $216,000 | |
| 3.10 | Cleanouts for underdrains | Each | 94 | $300.00 | $28,200 | |
| 3.11 | Keel Blocks | | | | | |
| 3.11.1 | Precast concrete bases | Each | 150 | $1,200.00 | $180,000 | Assume 6' wide x 3.5' high x 5.83' long |
| 3.11.2 | Timber blocking: Hardwood | MBF | 15 | $3,600.00 | $54,000 | |
| 3.11.3 | Timber blocking: Softwood caps | MBF | 108 | $1,500.00 | $162,000 | |
| 3.12 | Temporary Construction Access Ramp | LS | 1 | $90,000.00 | $90,000 | |
| | 3.0 Total | | | | $5,296,659 | |

# Table 5-7: Detailed Cost Estimate- Option 2 (Cont'd)

Alternative 1.3 (Option 2)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| | | | | | | |
| 4.0 | Dewatering/Drainage System: | | | | | |
| 4.1 | Pumpwell: | | | | | |
| 4.1.1 | Floor | CY | 28 | $400.00 | $11,200 | |
| 4.1.2 | Walls | CY | 176 | $400.00 | $70,400 | |
| 4.1.3 | Roof framing/grating | SF | 257 | $50.00 | $12,850 | |
| 4.2 | Submersible pumps, 7000 gpm w/controls | Each | 3 | $103,000.00 | $309,000 | May need 9700 gpm, if that exists. |
| 4.3 | Cross culverts, 24" | LF | 310 | $90.00 | $27,900 | Connect south side trench drains to north side pumpwell |
| 4.4 | Pipes to valve chamber, 18" | LF | 540 | $50.00 | $27,000 | Connect pumps to valve chamber in service bldg |
| 4.5 | Valves | LS | 1 | | $0 | |
| 4.6 | Valves/Valve chamber | LS | 1 | | $116,000 | 1-30" gate valve; 1 - 30" Tideflex valve; 3 - 18" plug valves 3 - 18" check valves; 4 air release valves |
| 4.7 | Valve controls | LS | 1 | | $0 | |
| 4.8 | Pump controls | LS | 1 | | $0 | |
| 4.9 | Outfall force main, 30" | LF | 255 | $80.00 | $20,400 | |
| 4.10 | Outfall structure | LS | 1 | | $20,000 | |
| | 4.0 Total | | | | $614,750 | |
| 5.0 | Site Improvements: | | | | | |
| 5.1 | Move monopiles | | | | | |
| 5.1.1 | Extract monopiles | Each | 4 | $5,000.00 | $20,000 | |
| 5.1.2 | Re-install monopiles | Each | 4 | $8,000.00 | $32,000 | |
| 5.2 | Gangways | | | | | One gangway, north side |
| 5.2.1 | Piles | LF | 1120 | $105.00 | $117,600 | Assume 16 piles 70' long |
| 5.2.2 | Pile Caps | CY | 43 | $450.00 | $19,350 | Assume 8 support bents |
| 5.2.3 | Spans | SF | 3040 | $35.00 | $106,400 | Assume 7 spans - Halcrow Note: Assume precast, prestressed with topping slab. |
| 5.2.4 | Guardrails | LF | 380 | $40.00 | $15,200 | Note: Assume standard FDOT guardail. |
| 5.3 | Redirect twin 16" drain pipes to channel | LF | 1300 | $34.00 | $44,200 | 650' from SE corner of basin to channel - Halcrow Note: Assume installation of new standard FDOT 0430175118 Pipe |
| 5.4 | Redirect 24" culvert to channel | LF | 1100 | $90.00 | $99,000 | 1100' from west side of basin to channel - Note: Assume installation of new standard FDOT 0430174124 Culvert. |
| 5.5 | Relocate primary electrical ship service | LS | 1 | | $202,000 | |
| 5.6 | Relocate ship water service | LS | 1 | | $60,000 | |
| 5.7 | Relocate ship wastewater service | LS | 1 | | | |
| 5.8 | Secondary Egress Staircase | LS | 1 | $50,000.00 | $50,000 | South side of ship, from ship deck to basin slab. Standard steel framed stack with intermediate landings in a scissors arrangement, concrete-filled treads 4' wide, overall height of 61'. |
| | 5.0 Total | | | | $765,750 | |
| 6.0 | Temporary Wet Berth: | | | | | |
| 6.1 | Wall Sheeting | LF | 960 | $2,400.00 | $2,304,000 | Zones A&B; 4814 lbs/ft |
| 6.2 | Wall Anchors | Each | 168 | $1,000.00 | $168,000 | Note - '1.75" dia Grade 75 threadbar, 62' long, inclusive of tie-rods, plates, and walers. |
| 6.3 | King pile side walls | LF | 320 | $10,390.00 | $3,324,800 | Zone D & D'; 10812 lbs/ft |
| 6.4 | King pile closure wall | LF | 160 | $10,390.00 | $1,662,400 | Zone C'; 10812 lbs/ft |
| 6.5 | Mooring Monopiles | Each | 4 | $160,000.00 | $640,000 | Note: Assume Large Pipe with Donut Fender |
| 6.6 | Pumping system to maintain water level | LS | 1 | | $120,000 | |
| 6.7 | Pumping system operation | months | | | $80,000 | |
| 6.8 | Backfill wet berth after dry berthing ship | CY | 82700 | $6.00 | $496,200 | Could use stockpiled excavated material |
| 6.9 | Features to maintain visitor ship access: | | | | | |
| 6.9.1 | Temporary Gangway & stair tower | Each | 1 | $35,750.00 | $35,750 | Note: Assume $225/lf @ 70' for gangway, $20,000 allowance for stair tower. |
| 6.9.2 | Temporary electric power | LS | 1 | | $30,000 | |
| 6.9.3 | Temporary water supply | LS | 1 | | $20,000 | |
| 6.9.4 | Temporary wastewater line | LS | 1 | | | |
| | 6.0 Total | | | | $8,881,150 | |
| 7.0 | Move Ship | | | | | |
| 7.1 | Temporary mooring fixtures/winches | LS | 1 | $280,100.00 | $280,100 | |
| 7.2 | Flood dry berth | Cycles | 1 | $46,375.00 | $46,375 | Assume basin volume = 52,000,000 gallons |
| 7.3 | Extract sheeting after dry berthing ship | LF | 1440 | $100.00 | $144,000 | |
| 7.4 | Move ship to dry berth | LS | 1 | $50,000.00 | $50,000 | |
| 7.5 | Dewater dry berth | Cycles | 1 | $55,650.00 | $55,650 | Assume basin volume = 52,000,000 gallons |
| 7.6 | Move ship to wet berth | LS | 1 | $50,000.00 | $50,000 | |
| ~~7.7~~ | ~~Superflood dry berth~~ | Cycles | 0 | | $0 | Not used for Alternative 1.3 |
| ~~7.8~~ | ~~Superflood wet berth~~ | Cycles | 0 | | $0 | Not used for Alternative 1.3 |
| | 7.0 Total | | | | $626,125 | |
| | | | | | | |
| | General Project Mobilization | LS | 1 | $1,000,000.00 | $1,000,000 | |
| | | | | | | |
| | SUB TOTAL | | | | $29,259,000 | |
| | Supervision, OH & P - 20% | | | | $5,851,800 | |
| | TOTAL COST | | | | $35,110,800 | |
| | Construction Contingency - 20% | | | | $7,022,000 | |
| | Engineering, Geotech Testing, CM -10% | | | | $4,213,280 | |
| | FINAL COST | | | | $46,346,080 | |

# Table 5-8: Detailed Cost Estimate- Option 3

Alternative 2.2B (Option 3)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| 1.0 | Dredging and Removals: | | | | | |
| 1.1 | Remove revetment armoring | SF | 24255 | $6.48 | $157,172 | 770LF x 31.5' wide |
| 1.2 | Remove existing gangway | LS | 1 | $5,000.00 | $5,000 | |
| 1.3 | Dredging mobilization/demobilization | LS | 1 | $200,000.00 | $200,000 | Assumed hydraulic dredging required for areas. |
| ~~1.4~~ | ~~Dredging for wet berth formation~~ | CY | 0 | $0.00 | $0 | Not used for Alternative 2.2B |
| 1.5 | Dredging for ship move | CY | 80600 | $12.00 | $967,200 | |
| 1.6 | Dredging for dry berth basin formation | CY | 0 | $0.00 | $0 | |
| 1.7 | Dredge placement fee and testing | CY | 80600 | $10.00 | $806,000 | |
| 1.8 | Pipeline | LS | 1 | $200,000.00 | $200,000 | |
| 1.9 | Excavation in dry for basin formation, after dewatering | CY | 263800 | $6.50 | $1,714,700 | Stockpile suitable material for use as fill |
| 1.10 | Temporary Platform for Marine Access | LS | 1 | $250,000.00 | $250,000 | |
| ~~1.11~~ | ~~Excavation in dry for wet berth formation~~ | CY | 0 | | $0 | Not used for Alternative 2.2B |
| 1.12 | Disposed unused excavated fill | CY | 243000 | $4.00 | $972,000 | Assumed disposal on TPWD site |
| | 1.0 Total | | | | $5,272,072 | |
| 2.0 | Dry Berth Wall Construction: | | | | | |
| 2.1 | King pile cantilever cofferdam | | | | | |
| 2.1.1 | Wall - Type 1 | LF | 900 | $7,779.00 | $7,001,100 | Zones A, B and C; 8310 lbs/ft |
| 2.1.2 | Wall - Type 2 | LF | 150 | $10,529.00 | $1,579,350 | Zone F; 10,996 lbs/ft -Note: Wall type in description does not match wall type in bulkhead descriptions; Halcrow assumes a TYPE 1 Wall. |
| 2.1.3 | Wall - Type 3 | LF | 135 | $2,294.00 | $309,690 | Zone D; 2410 lbs/ft AZ38 sheeting, no king piles - Note: There is no wall type for this wall in the bulkhead description document, will assume bulkhead description document is correct, not Item Description. |
| 2.1.4 | Promenade on top of wall | LF | 1330 | $460.00 | $611,800 | Assume 12 feet wide conc. deck with guard rails each side |
| 2.2 | Fill | CY | 20800 | $6.00 | $124,800 | Could use stockpiled excavated material |
| 2.3 | Access ramp on grade | | | | | |
| 2.3.1 | Paving | SF | 13200 | $10.00 | $132,000 | 1100 LF x 12' wide; assume 10" thick concrete |
| 2.3.2 | Trench drain | LF | 1020 | $180.00 | $183,600 | |
| 2.3.3 | Guard rails | LF | 1100 | $40.00 | $44,000 | |
| 2.4 | Landscaping | | | | | |
| 2.4.1 | Topsoil | SF | 210874 | $0.63 | $131,796 | |
| 2.4.2 | Grass | SF | 210874 | $1.50 | $316,311 | Bermuda grass |
| 2.4.3 | Concrete paved apron at toe of slope | SF | 11035 | $5.50 | $60,693 | Assume 8" thick |
| 2.4.4 | Filter stone | CY | 7700 | $66.00 | $508,200 | |
| 2.4.5 | Filter fabric | SF | 415000 | $0.50 | $207,500 | |
| 2.4.6 | Egress Stairway up slope | LF | 160 | $200.00 | $32,000 | Concrete staircase, 52' rise, 6' wide w/handrails ea side |
| 2.5 | Underdrain perforated piping | LF | 14500 | $4.50 | $65,250 | |
| 2.6 | Cleanouts for underdrains | Each | 250 | $300.00 | $75,000 | |
| 2.7 | Dike | | | | | |
| 2.7.1 | Fill | CY | 0 | $6.00 | $0 | Included in Item 2.2. |
| 2.7.2 | Paving | SF | 9120 | $10.00 | $91,200 | 760 ft long @ 12' wide |
| 2.8 | Temporary dewatering system for construction | | | | | |
| 2.8.1 | Supply wellpoint system and pumps | LS | 1 | | $200,000 | |
| 2.8.2 | Dewater dry berth basin for construction | LS | 1 | $39,750.00 | $39,750 | Assume basin volume = 46,000,000 gallons. Understood actual volume will be less prior to excavation/dredging, taken to be conservative. |
| 2.8.3 | Maintain dry basin | Months | | | $40,000 | |
| 2.9 | Temporary closure sheeting | LF | 200 | $1,874.00 | $374,800 | Zone E; 1223 lbs/ft |
| | 2.0 Total | | | | $12,128,840 | |
| 3.0 | Dry Berth Slab Construction: | | | | | |
| 3.1 | Piles | | | | | |
| 3.1.1 | 36" concrete piles, 300t (120' lg) | Each | 34 | $13,670.00 | $464,780 | |
| 3.1.2 | 36" concrete piles, 250t (105' lg) | Each | 78 | $12,045.00 | $939,510 | |
| 3.1.3 | 36" concrete piles, 200t (90' lg) | Each | 128 | $10,475.00 | $1,340,800 | |
| 3.2 | Pile caps | CY | 1293 | $425.00 | $549,525 | |
| 3.3 | Structural slab | CY | 873 | $375.00 | $327,375 | |
| 3.4 | Pavement slab | SF | 48874 | $10.50 | $513,177 | |
| 3.5 | Filter stone | CY | 4168 | $66.00 | $275,088 | |
| 3.6 | Filter fabric | SF | 67007 | $0.50 | $33,504 | |
| 3.7 | Underdrain piping | LF | 5900 | $9.00 | $53,100 | |
| 3.8 | Floor drains/relief vents | Each | 464 | $150.00 | $69,600 | |
| 3.9 | Perimeter trench drain | LF | 1200 | $180.00 | $216,000 | |
| 3.10 | Cleanouts for underdrains | Each | 94 | $300.00 | $28,200 | |
| 3.11 | Keel Blocks | | | | | |
| 3.11.1 | Precast concrete bases | Each | 150 | $1,200.00 | $180,000 | Assume 6' wide x 3.5' high x 5.83' long |
| 3.11.2 | Timber blocking: Hardwood | MBF | 15 | $3,600.00 | $54,000 | |
| 3.11.3 | Timber blocking: Softwood caps | MBF | 108 | $1,500.00 | $162,000 | |
| 3.12 | Tempoary Construction Access Ramp | LS | 1 | $60,000.00 | $60,000 | |
| | 3.0 Total | | | | $5,266,659 | |

# Table 5-8: Detailed Cost Estimate- Option 3 (Cont'd)

Alternative 2.2B (Option 3)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| | | | | | | |
| 4.0 | Dewatering/Drainage System: | | | | | |
| 4.1 | Pumpwell: | | | | | |
| 4.1.1 | Floor | CY | 28 | $400.00 | $11,200 | |
| 4.1.2 | Walls | CY | 176 | $400.00 | $70,400 | |
| 4.1.3 | Roof framing/grating | SF | 257 | $50.00 | $12,850 | |
| 4.2 | Submersible pumps, 7,000 gpm w/controls | Each | 3 | $103,000.00 | $309,000 | |
| 4.3 | Cross culverts, 24" | LF | 310 | $90.00 | $27,900 | Connect south side trench drains to north side pumpwell |
| 4.4 | Pipes to valve chamber, 18" | LF | 540 | $50.00 | $27,000 | Connect pumps to valve chamber in service bldg |
| 4.5 | Valves | LS | 1 | | $0 | |
| 4.6 | Valves/Valve chamber | LS | 1 | | $116,000 | 1-30" gate valve; 1 - 30" Tideflex valve; 3 - 18" plug valves 3 - 18" check valves; 4 air release valves |
| 4.7 | Valve controls | LS | 1 | | $20,000 | |
| 4.8 | Pump controls | LS | 1 | | $0 | |
| 4.9 | Outfall force main, 30" | LF | 130 | $80.00 | $10,400 | |
| 4.10 | Outfall structure | LS | 1 | | $2,000 | |
| | 4.0 Total | | | | $606,750 | |
| 5.0 | Site Improvements: | | | | | |
| 5.1 | Furnish and install monopiles | Each | 4 | $160,000.00 | $640,000 | |
| ~~5.1.1~~ | ~~Extract monopiles~~ | Each | 0 | | $0 | Not used for Alternative 2.2B |
| ~~5.1.2~~ | ~~Re-install monopiles~~ | Each | 0 | | $0 | Not used for Alternative 2.2B |
| 5.2 | Gangways | | | | | One gangway, north side, 190' long |
| 5.2.1 | Piles | LF | 1120 | $105.00 | $117,600 | Asume 16 piles 70' long - Halcrow Note: Assume 24" concrete piles. |
| 5.2.2 | Pile Caps | CY | 43 | $450.00 | $19,350 | Assume 8 support bents |
| 5.2.3 | Spans | SF | 3040 | $35.00 | $106,400 | Assume 7 spans - Note: Assume precast, prestressed with topping slab. |
| 5.2.4 | Guardrails | LF | 380 | $40.00 | $15,200 | |
| ~~5.3~~ | ~~Redirect twin 16" drain pipes to channel~~ | LF | 0 | | $0 | Not used for Alternative 2.2B |
| ~~5.4~~ | ~~Redirect 24" culvert to channel~~ | LF | 0 | | $0 | Not used for Alternative 2.2B |
| 5.5 | Relocate primary electrical ship service | LS | 1 | | $168,000 | |
| 5.6 | Relocate ship water service | LS | 1 | | $60,000 | |
| 5.7 | Relocate ship wastewater service | LS | 1 | | | |
| | 5.0 Total | | | | $1,126,550 | |
| ~~6.0~~ | ~~Temporary Wet Berth:~~ | | | | | Not used for Alternative 2.2B |
| ~~6.1~~ | ~~Wall Sheeting~~ | LF | 0 | | $0 | |
| ~~6.2~~ | ~~Wall Anchors~~ | Each | 0 | | $0 | |
| ~~6.3~~ | ~~King pile side walls~~ | LF | 0 | | $0 | |
| ~~6.4~~ | ~~King pile closure wall~~ | LF | 0 | | $0 | |
| ~~6.5~~ | ~~Mooring Monopiles~~ | Each | 0 | | $0 | |
| ~~6.6~~ | ~~Pumping system to maintain water level~~ | LS | 0 | | $0 | |
| ~~6.7~~ | ~~Pumping system operation~~ | months | 0 | | $0 | |
| ~~6.8~~ | ~~Backfill wet berth after dry berthing ship~~ | CY | 0 | | $0 | |
| ~~6.9~~ | ~~Extract sheeting after dry berthing ship~~ | LF | 0 | | $0 | |
| ~~6.1~~ | ~~Features to maintain visitor ship access:~~ | | | | $0 | |
| ~~6.10.1~~ | ~~Temporary Gangway & stair tower~~ | Each | 0 | | $0 | |
| ~~6.10.2~~ | ~~Temporary electric power~~ | LS | 0 | | $0 | |
| ~~6.10.3~~ | ~~Temporary water supply~~ | LS | 0 | | $0 | |
| ~~6.10.4~~ | ~~Temporary wastewater line~~ | LS | 0 | | $0 | |
| | 6.0 Total | | | | $0 | |
| 7.0 | Move Ship | | | | | |
| 7.1 | Temporary mooring fixtures/winches | LS | 1 | $280,100.00 | $280,100 | |
| 7.2 | Flood dry berth | Cycles | 1 | $39,750.00 | $39,750 | Basin Volume = 46,000,000 gallons |
| 7.3 | Move ship to dry berth | LS | 1 | $96,000.00 | $96,000 | |
| 7.4 | Dewater dry berth | Cycles | 1 | $47,700.00 | $47,700 | |
| ~~7.5~~ | ~~Move ship to wet berth~~ | LS | 0 | | $0 | Not used for Alternative 2.2B |
| ~~7.6~~ | ~~Superflood dry berth~~ | Cycles | 0 | | $0 | Not used for Alternative 2.2B |
| ~~7.7~~ | ~~Superflood wet berth~~ | Cycles | 0 | | $0 | Not used for Alternative 2.2B |
| 7.8 | Remove temporary dry berth closure | LF | 200 | $475.00 | $95,000 | |
| | 7.0 Total | | | | $558,550 | |
| | | | | | | |
| | General Project Mobilization | LS | 1 | $1,000,000.00 | $1,000,000 | |
| | | | | | | |
| | SUB TOTAL | | | | $25,959,000 | |
| | Supervision, OH & P - 20% | | | | $5,191,800 | |
| | TOTAL COST | | | | $31,150,800 | |
| | Construction Contingency - 20% | | | | $6,230,000 | |
| | Engineering, Geotech Testing, CM -10% | | | | $3,738,080 | |
| | FINAL COST | | | | $41,118,880 | |

# Table 5-9: Detailed Cost Estimate- Option 4

Alternative 3.0 (Option 4)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1.0 | Dredging and Removals: | | | | | |
| 1.1 | Remove revetment armoring | SF | 7560 | $6.48 | $48,989 | 240 LF x 31.5' wide |
| 1.2 | Remove existing gangway | LS | 1 | $5,000.00 | $5,000 | |
| 1.3 | Dredging mobilization/demobilization | LS | 1 | $50,000.00 | $50,000 | Note: Does not include costs for temporary working platform. |
| ~~1.4~~ | ~~Dredging for wet berth formation~~ | ~~CY~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| 1.5 | Dredging for ship move | CY | 58383 | $12.00 | $700,596 | Note: To be performed mechanically from temporary working platform. |
| 1.6 | Dredging for dry berth basin formation | CY | 0 | $0.00 | $0 | Assume all done as excavation with lanside equipment within slurry walls. |
| 1.7 | Dredge placement fee and testing | CY | 58383 | $0.00 | $0 | Note: Not Applicable, Assume mechanical dredging. |
| 1.8 | Pipeline | LS | 1 | $0.00 | $0 | No pipeline needed, dredging to be performed mechanically. |
| 1.9 | Excavation in dry for basin formation, after dewatering | CY | 153185 | $6.50 | $995,703 | Stockpile suitable material for use as fill |
| 1.10 | Temporary Platform for Marine Access | LS | 1 | $350,000.00 | $350,000 | |
| ~~1.11~~ | ~~Excavation in dry for wet berth formation~~ | ~~CY~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| 1.12 | Disposed unused excavated fill | CY | 134385 | $4.00 | $537,540 | Assumed disposal on TPWD site |
| | 1.0 Total | | | | $2,687,827 | |
| 2.0 | Dry Berth Wall Construction: | | | | | |
| 2.1 | Walls | | | | | |
| 2.1.1 | King pile cantilever cofferdam | LF | 160 | $16,408.00 | $2,625,280 | Zone E; 17676 lbs/ft |
| 2.1.2 | Perimeter slurry wall | LF | 1330 | $6,667.00 | $8,867,110 | Assumption on cost data from Nicholson Construction |
| 2.1.3 | Soil Anchors for slurry wall | Each | 666 | $4,167.00 | $2,775,222 | Assumption on cost data from Nicholson Construction |
| 2.1.4 | King pile cantilever dredge retention sheeting | LF | 380 | $4,455.00 | $1,692,900 | Zone D; 4442 lbs/ft |
| ~~2.1.4~~ | ~~Promenade on top of wall~~ | ~~LF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~2.2~~ | ~~Fill~~ | ~~CY~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| 2.3 | Access ramp on structure | | | | | Structural ramp rather than pavement on grade |
| 2.3.1 | Deck spans | SF | 18900 | $50.00 | $945,000 | 1050' long x 18' wide; Assume 35 spans of 30' each |
| 2.3.2 | Scuppers and leaders | Each | 18 | $1,000.00 | $18,000 | Leaders drain to floor. Average leader height 26'. |
| 2.3.3 | Guard rails | LF | 1050 | $40.00 | $42,000 | |
| 2.3.4 | Pile caps | CY | 288 | $450.00 | $129,600 | 36 caps, 4'x3'x18' |
| 2.3.5 | Piles | Each | 72 | $8,063.00 | $580,536 | Assume piles to be 22' long, 36" Dia. |
| 2.3.6 | Columns | Each | 72 | $9,530.00 | $686,160 | Assume columns to be 26' long, 36" Dia. |
| 2.3.7 | Cross Beams | CY | 0 | $450.00 | $0 | Assume pile cap serve function - Assume 42" wide x 30" tall x 18' long. - Halcrow Note: Is this item needed? |
| 2.4 | Landscaping | SF | | | | |
| ~~2.4.1~~ | ~~Topsoil~~ | ~~SF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~2.4.2~~ | ~~Grass~~ | ~~SF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~2.4.3~~ | ~~Concrete paved apron at toe of slope~~ | ~~SF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~2.4.4~~ | ~~Filter stone~~ | ~~CY~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~2.4.5~~ | ~~Filter fabric~~ | ~~SF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~2.5~~ | ~~Underdrain perforated piping~~ | ~~LF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~2.6~~ | ~~Cleanouts for underdrains~~ | ~~Each~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| 2.7 | Dike | | | | | |
| 2.7.1 | Fill | CY | 18800 | $6.00 | $112,800 | Could use stockpiled execavated material |
| 2.7.2 | Paving | SF | 18000 | $10.00 | $180,000 | Say 1500' x 12' wide |
| 2.8 | Temporary dewatering system for construction | | | | | |
| 2.8.1 | Supply wellpoint system and pumps | LS | 1 | | $40,000 | |
| 2.8.2 | Dewater dry berth basin for construction | LS | 1 | $6,625.00 | $6,625 | Assume a nominal volume of 1,000,000 gallons (max 1 day of pumping) |
| 2.8.3 | Maintain dry basin | Months | | | $0 | |
| 2.9 | Temporary closure sheeting | LF | 295 | $1,874.00 | $552,830 | Zones A, B & C; 3887 lbs/ft |
| | 2.0 Total | | | | $19,254,063 | |
| 3.0 | Dry Berth Slab Construction: | | | | | |
| 3.1 | Piles | | | | | |
| 3.1.1 | 36" concrete piles, 300t (120' lg) | Each | 34 | $13,670.00 | $464,780 | |
| 3.1.2 | 36" concrete piles, 250t (105' lg) | Each | 78 | $12,045.00 | $939,510 | |
| 3.1.3 | 36" concrete piles, 200t (90' lg) | Each | 128 | $10,475.00 | $1,340,800 | |
| 3.2 | Pile caps | CY | 1293 | $425.00 | $549,525 | |
| 3.3 | Structural slab | CY | 873 | $375.00 | $327,375 | |
| 3.4 | Pavement slab | SF | 84682 | $10.50 | $889,161 | |
| 3.5 | Filter stone | CY | 6600 | $66.00 | $435,600 | |
| 3.6 | Filter fabric | SF | 102800 | $0.50 | $51,400 | |
| 3.7 | Underdrain piping | LF | 8400 | $9.00 | $75,600 | Assume 4" perforated PVC wrapped in fabric |
| 3.8 | Floor drains/relief vents | Each | 1160 | $150.00 | $174,000 | |
| 3.9 | Perimeter trench drain | LF | 1068 | $180.00 | $192,240 | |
| 3.10 | Cleanouts for underdrains | Each | 136 | $300.00 | $40,800 | |
| 3.11 | Keel Blocks | | | | | |
| 3.11.1 | Precast concrete bases | Each | 150 | $1,200.00 | $180,000 | Assume 6' wide x 3.5' high x 5.83' long |
| 3.11.2 | Timber blocking: Hardwood | MBF | 15 | $3,600.00 | $54,000 | |
| 3.11.3 | Timber blocking: Softwood caps | MBF | 108 | $1,500.00 | $162,000 | |
| | 3.0 Total | | | | $5,876,791 | |

# Table 5-9: Detailed Cost Estimate-Option 4 (Cont'd)

Alternative 3.0 (Option 4)

| Item Number | Item Description | Unit | Quantity | Unit Cost | Cost | Comment |
|---|---|---|---|---|---|---|
| | | | | | | |
| 4.0 | Dewatering/Drainage System: | | | | | |
| 4.1 | Pumpwell: | | | | | |
| 4.1.1 | Floor | CY | 28 | $400.00 | $11,200 | |
| 4.1.2 | Walls | CY | 176 | $400.00 | $70,400 | |
| 4.1.3 | Roof framing/grating | SF | 257 | $50.00 | $12,850 | |
| 4.2 | Submersible pumps, 7,000 gpm w/ controls | Each | 3 | $103,000.00 | $309,000 | Req'd capacity can probably be reduced. |
| 4.3 | Cross culverts, 18" | LF | 240 | $90.00 | $21,600 | Connect south side trench drains to north side pumpwell |
| 4.4 | Pipes to valve chamber, 14" | LF | 300 | $50.00 | $15,000 | Connect pumps to valve chamber. 3 pipes, 50' horiz & 50' up. |
| 4.5 | Valves | LS | 1 | | $0 | |
| 4.6 | Valves/Valve chamber | LS | 1 | | $116,000 | 1-24" gate valve; 1 - 24" Tideflex valve; 3-14" plug valves; 3-14" check valves; 4 air release valves |
| 4.7 | Valve controls | LS | 1 | | $20,000 | |
| 4.8 | Pump controls | LS | 1 | | $0 | |
| 4.9 | Outfall force main, 24" | LF | 550 | $80.00 | $44,000 | |
| 4.10 | Outfall structure | LS | 1 | | $20,000 | |
| | 4.0 Total | | | | $640,050 | |
| 5.0 | Site Improvements: | | | | | |
| 5.1 | Furnish and install monopiles | Each | 4 | $160,000.00 | $640,000 | |
| ~~5.1.1~~ | ~~Extract monopiles~~ | ~~Each~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~5.1.2~~ | ~~Re-install monopiles~~ | ~~Each~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| 5.2 | Gangways | | | | | Main gangway south side; auxiliary gangway north side |
| ~~5.2.1~~ | ~~Piles~~ | ~~LF~~ | 0 | $105.00 | $0 | AECOM - Items not required |
| ~~5.2.2~~ | ~~Pile Caps~~ | ~~CY~~ | 0 | $450.00 | $0 | AECOM - Items not required |
| 5.2.3 | Spans | SF | 1360 | $50.00 | $68,000 | Assume 60' span 16' wide through truss on south side; 50' stringer span 8' wide north side. |
| 5.2.4 | Guardrails | LF | 220 | $40.00 | $8,800 | |
| ~~5.3~~ | ~~Redirect twin 16" drain pipes to channel~~ | ~~LF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| 5.4 | Redirect 24" culvert to channel | LF | 530 | $90.00 | $47,700 | Note: Assume Installation of New Standard FDOT 0430174124 Culvert |
| 5.5 | Relocate primary electrical ship service | LS | 1 | | $134,000 | |
| 5.6 | Relocate ship water service | LS | 1 | | $60,000 | |
| 5.7 | Relocate ship wastewater service | LS | 1 | | | |
| 5.8 | Secondary Egress Staircase | LS | 1 | $50,000.00 | $50,000 | Southwest corner of basin, from basin slab (-38') to topside (+14'). Standard steel framed stack with intermediate landings in a scissors arrangement, concrete-filled treads 4' wide, overall height of 61'. |
| 5.9 | Dock perimeter guardrails | LF | 1400 | $40.00 | $56,000 | |
| | 5.0 Total | | | | $1,064,500 | |
| ~~6.0~~ | ~~Temporary Wet Berth:~~ | | | | | ~~Not used for Alternative 3.0~~ |
| ~~6.1~~ | ~~Wall Sheeting~~ | ~~LF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.2~~ | ~~Wall Anchors~~ | ~~Each~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.3~~ | ~~King pile side walls~~ | ~~LF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.4~~ | ~~King pile closure wall~~ | ~~LF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.5~~ | ~~Mooring Monopiles~~ | ~~Each~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.6~~ | ~~Pumping system to maintain water level~~ | ~~LS~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.7~~ | ~~Pumping system operation~~ | ~~months~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.8~~ | ~~Backfill wet berth after dry berthing ship~~ | ~~CY~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.9~~ | ~~Extract sheeting after dry berthing ship~~ | ~~LF~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.1~~ | ~~Features to maintain visitor ship access:~~ | | | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.10.1~~ | ~~Temporary Gangway & stair tower~~ | ~~Each~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.10.2~~ | ~~Temporary electric power~~ | ~~LS~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.10.3~~ | ~~Temporary water supply~~ | ~~LS~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~6.10.4~~ | ~~Temporary wastewater line~~ | ~~LS~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| | 6.0 Total | | | | $0 | |
| 7.0 | Move Ship | | | | | |
| 7.1 | Temporary mooring fixtures/winches | LS | 1 | $280,100 | $280,100 | |
| 7.2 | Flood dry berth | Cycles | 1 | $33,125 | $33,125 | Assume basin volume = 32,000,000 gallons |
| 7.3 | Move ship to dry berth | LS | 1 | $96,000 | $96,000 | |
| 7.4 | Dewater dry berth | Cycles | 1 | $39,750 | $39,750 | Assume basin volume = 32,000,000 gallons |
| ~~7.5~~ | ~~Move ship to wet berth~~ | ~~LS~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~7.6~~ | ~~Superflood dry berth~~ | ~~Cycles~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| ~~7.7~~ | ~~Superflood wet berth~~ | ~~Cycles~~ | ~~0~~ | | ~~$0~~ | ~~Not used for Alternative 3.0~~ |
| 7.8 | Remove temporary dry berth closure | LF | 295 | $475 | $140,125 | |
| | 7.0 Total | | | | $589,100 | |
| | | | | | | |
| | General Project Mobilization | LS | 1 | $1,000,000 | $1,000,000 | |
| | | | | | | |
| | SUB TOTAL | | | | $31,112,000 | |
| | Supervision, OH & P - 20% | | | | $6,222,400 | |
| | TOTAL COST | | | | $37,334,400 | |
| | Construction Contingency - 20% | | | | $7,467,000 | |
| | Engineering, Geotech Testing, CM -10% | | | | $4,480,140 | |
| | FINAL COST | | | | $49,281,540 | |

Table 5-10: Detailed Cost Estimate

ESTIMATED COST FOR DRYDOCKING THE TEXAS BATTLESHIP

| Item | Quantity | Unit | Unit Price | Amount |
|---|---|---|---|---|
| **INITIAL DRYDOCKING** | | | | |
| **A. Ship Preparation** | | | | |
| Ballasting/de-ballasting of ship to near- level trim | LS | ---------- | | $8,000 |
| Rentals of generators (2) 400 amp 440 V AC three phase (two weeks/to-from) | LS | ---------- | | $27,000 |
| Rentals of portable heads (2) to/from shipyard | LS | ---------- | | $4,000 |
| Catering aboard (water, food for crew) | LS | ---------- | | $1,000 |
| EMT onboard with 1st Aid | LS | ---------- | | $1,500 |
| Crane service on/off gensets | LS | ---------- | | $4,500 |
| Fuel (diesel assuming $ 4.50/gallon x 2,000 gallons | 2,000 | GALLON | $4.50 | $9,000 |
| Procurement/rental & placement of 3"pick-up hoses, 3" discharge hoses and relate 18 pumps, power cords (two weeks/to-from | LS | ---------- | | $25,000 |
| Removal/re -installation of utilities & gangway w/ crane service & flatbed trailer | LS | ---------- | | $67,000 |
| Removal and re-installation of mooring cells (to/from Park) assuming tug time, fabrication crew/crane/barge service | LS | ---------- | | $70,000 |
| Secure ship for sea; close all hatches, watertight doors/scuttles, tie down all loose gear, secure vessel's collection from pilfering | LS | ---------- | | $30,000 |
| Damage control team (30 men skilled at dewatering ship/salvage crew) to/from Shipyard | LS | ---------- | | $60,000 |
| Certificate of Financial Responsibility (Wreck removal insurance, 6 month policy) | LS | ---------- | | $100,000 |
| Liability insurance (crew) | LS | ---------- | | $45,000 |
| Trip & Tow Surveys & Tow Plans preparation to/from shipyard | LS | ---------- | | $80,000 |
| **Subtotal A: Ship Preparation** | | | | $532,000 |
| **B. Shipyard Costs: General Service & Drydocking** | | | | |
| a. Drydocking – 150 days | | | | |
| 1. Preparation of drydock. Procurement of blocks and setting blocks to Docking Plan | LS | ---------- | | $145,000 |
| 2. Blocking | LS | ---------- | | $60,000 |
| 3. Haul day | LS | ---------- | | $25,000 |
| 4. Lay days – 150 @ $ 15,000/day | 150 | DAY | $15,000 | $2,250,000 |
| b. Services | | | | |
| 1. Linehandlers per side only, arrival & departure | LS | ---------- | | $16,000 |
| 2. Crane service – per hour for Owner's use (estimated 50 hrs) @ $ 300.00/hr | 50 | HR | $300 | $15,000 |
| 3. Shore power – 440V AC 3 Phase 60 HZ | | | | |
| Connect/disconnect – one time | LS | ---------- | | $1,800 |
| Supply per day @ $ 2,400.00/day x 150 | 150 | DAY | $2,400 | $360,000 |
| 4. Fire watches – included in hot work items | | | | |
| 5. Fire lines | | | | |
| Connect/disconnect – one time | LS | ---------- | | $1,800 |
| Maintain per day @ 100.00/day | 150 | DAY | $100 | $15,000 |
| 6. Security services – gangway guard @ $ 1380/day | 150 | DAY | $1,380 | $207,000 |
| 7. Potable water | | | | |
| Connect/disconnect – one time | LS | ---------- | | $1,800 |
| Supply per ton $ 5.50/ton, average is 3 tons/day | 450 | TON | $5.50 | $2,475 |
| Maintain per day @ 100.00/day | 150 | DAY | $100 | $15,000 |
| 8. Fleeting movement – one time | | | | $84,000 |
| 9. Asbestos abatement (estimated for limited tank access routes) | LS | ---------- | | $225,000 |
| 10. Tank Cleaning and gas-freeing of tanks (including disposal) | LS | ---------- | | $2,775,000 |

Table 5-10: Detailed Cost Estimate (Cont'd)

ESTIMATED COST FOR DRYDOCKING THE TEXAS BATTLESHIP

| Item | Quantity | Unit | Unit Price | Amount |
|---|---|---|---|---|
| 11. Marine Chemist | | | | |
| Initial visit | LS | ---------- | | $24,000 |
| Follow-up visits @ $ 1,440/day @ 30 day | 30 | DAY | $1,440 | $43,200 |
| 12. Shell plate repair | | | | |
| NOTE: Underwater wetted surface is 68,000 sq. ft.. Estimate 40% | | | | |
| Plate replacement at time of 1st drydocking with subsequent | | | | |
| drydocking intervals to repair the remaining 60% of plating. | | | | |
| Shell plate replacement 27,200 sq. ftx $ 775.00/sq. ft. | 27,200 | SQFT | $775 | $21,080,000 |
| Scantling repair (hull & blisters) estimated at 8,500 sq. ftx $ 775.00/sq. ft | 8,500 | SQFT | $775 | $6,587,500 |
| 13. Misc. repairs | | | | |
| Anchor & chain (2), hydroblast, prime & paint | LS | ---------- | | $70,000 |
| Paint draft numbers (fwd, amidships & aft | LS | ---------- | | $15,000 |
| c. Hydro-blasting & Painting (exterior) | | | | |
| Hydro-blasting of exterior hull from deck to keel @ 4.30/sq. ft x 98,000 sq. ft. | 98,000 | SQFT | $4.30 | $421,400 |
| Paint exterior hull, two coats @ $ 3.0 0/sq. ft x 98,000 sq. ft. | 98,000 | SQFT | $3.00 | $294,000 |
| Paint materials 98,000/300 sq. ft x $100/gallon x 2 coats | 654 | GALLON | $100 | $65,400 |
| d. Painting of interior new plating and scantlings, 2 coats epoxy primer 27,200 + 8,500 sq. ft x $ 3.00 sq. ft x 2 coats | 71,400 | SQFT | $3.00 | $214,200 |
| e. Red lead remediation of interior cut/burn at frames/bulk heads where new plating and scantling would be fitted | LS | ---------- | | $2,400,000 |
| Disposal of waste @ $ 360.00/55 gal. drum x 200 | 200 | DRUM | $360 | $72,000 |
| f. Completion washdown & cleaning of vessel | LS | ---------- | | $14,500 |
| **Subtotal B: Shipyard Costs** | | | | $37,501,075 |
| **C: Tugs, Pilots, Docking Master to/from Galveston assuming 8 hrs four tugs** | | | | $46,000 |
| **ROM Total Initial Drydocking Costs** | | | | $38,079,075 |

Table 5-10: Detailed Cost Estimate (Cont'd)

ESTIMATED COST FOR DRYDOCKING THE TEXAS BATTLESHIP

| Item | Quantity | Unit | Unit Price | Amount |
|---|---|---|---|---|
| **2nd DRYDOCKING 15 YEARS** | | | | |
| **A. Ship Preparation** | | | | |
| Ballasting/de-ballasting of ship to near- level trim | LS | ---------- | | $8,000 |
| Rentals of generators (2) 400 amp 440 V AC three phase (two weeks/to-from) | LS | ---------- | | $27,000 |
| Rentals of portable heads (2) to/from shipyard | LS | ---------- | | $4,000 |
| Catering aboard (water, food for crew) | LS | ---------- | | $1,000 |
| EMT onboard with 1st Aid | LS | ---------- | | $1,500 |
| Crane service on/off gensets | LS | ---------- | | $4,500 |
| Fuel (diesel assuming $ 4.50/gallon x 2,000 gallons | 2,000 | GALLON | $4.50 | $9,000 |
| Procurement/rental & placement of 3” pick-up hoses, 3” discharge hoses and relate 18 pumps, power cords (two weeks/to-from | LS | ---------- | | $25,000 |
| Removal/re -installation of utilities & gangway w/ crane service & flatbed trailer | LS | ---------- | | $67,000 |
| Removal and re-installation of mooring cells (to/from Park) assuming tug time, fabrication crew/crane/barge service | LS | ---------- | | $70,000 |
| Secure ship for sea; close all hatches, watertight doors/scuttles, tie down all loose gear, secure vessel’s collection from pilfering | LS | ---------- | | $30,000 |
| Damage control team (30 men skilled at dewatering ship/salvage crew) to/from Shipyard | LS | ---------- | | $60,000 |
| Certificate of Financial Responsibility (Wreck removal insurance, 6 month policy) | LS | ---------- | | $100,000 |
| Liability insurance (crew) | LS | ---------- | | $45,000 |
| Trip & Tow Surveys & Tow Plans preparation to/from shipyard | LS | ---------- | | $80,000 |
| **Subtotal A: Ship Preparation** | | | | $532,000 |
| **B. Shipyard Costs: General Service & Drydocking** | | | | |
| a. Drydocking – 100 days | | | | |
| 1. Preparation of drydock. Procurement of blocks and setting blocks to Docking Plan | LS | ---------- | | $145,000 |
| 2. Blocking | LS | ---------- | | $60,000 |
| 3. Haul day | LS | ---------- | | $25,000 |
| 4. Lay days – 100 @ $ 15,000/day | 100 | DAY | $15,000 | $1,500,000 |
| b. Services | | | | |
| 1. Linehandlers per side only, arrival & departure | LS | ---------- | | $16,000 |
| 2. Crane service – per hour for Owner’s use (estimated 50 hrs) @ $ 300.00/hr | 50 | HR | $300 | $15,000 |
| 3. Shore power – 440V AC 3 Phase 60 HZ | | | | |
| Connect/disconnect – one time | LS | ---------- | | $1,800 |
| Supply per day @ $ 2,400.00/day x 100 | 100 | DAY | $2,400 | $240,000 |
| 4. Fire watches – included in hot work items | | | | |
| 5. Fire lines | | | | |
| Connect/disconnect – one time | LS | ---------- | | $1,800 |
| Maintain per day @ 100.00/day | 100 | DAY | $100 | $10,000 |
| 6. Security services – gangway guard @ $ 138/hrs | 100 | DAY | $1,380 | $138,000 |
| 7. Potable water | | | | |
| Connect/disconnect – one time | LS | ---------- | | $1,800 |
| Supply per ton $ 5.50/ton, average is 3 tons/day | 300 | TON | $5.50 | $1,650 |
| Maintain per day @ 100.00/day | 100 | DAY | $100 | $10,000 |
| 8. Fleeting movement – one time | LS | ---------- | | $84,000 |
| 9. Asbestos abatement (estimated for limited tank access routes) | LS | ---------- | | $225,000 |
| 10. Tank Cleaning and gas-freeing of tanks (including disposal) | LS | ---------- | | $2,775,000 |

Table 5-10: Detailed Cost Estimate (Cont'd)

ESTIMATED COST FOR DRYDOCKING THE TEXAS BATTLESHIP

| Item | Quantity | Unit | Unit Price | Amount |
|---|---|---|---|---|
| 11. Marine Chemist | | | | |
| Initial visit | LS | ---------- | | $24,000 |
| Follow-up visits @ $ 1,440/day @ 20 days | 20 | DAY | $1,440 | $28,800 |
| 12. Shell plate repair | | | | |
| NOTE: Underwater wetted surface is 68,000 sq. ft.. Estimate 40% | | | | |
| Plate replacement at time of 1st drydocking with subsequent | | | | |
| drydocking intervals to repair the remaining 30% of plating. | | | | |
| Shell plate replacement 20,400 sq. ftx $ 775.00/sq. ft. | ####### | SQFT | $775 | $15,810,000 |
| Scantling repair (hull & blisters) estimated at 5,000 sq. ftx $ 775.00/sq. ft | 5,000 | SQFT | $775 | $3,875,000 |
| 13. Misc. repairs | | | | |
| Anchor & chain (2), hydroblast, prime & paint | LS | ---------- | | $70,000 |
| Paint draft numbers (fwd, amidships & aft | LS | ---------- | | $15,000 |
| c. Hydro-blasting & Painting (exterior) | | | | |
| Hydro-blasting of exterior hull from deck to keel @ 4.30/sq. ft x 98,000 sq. ft. | 98,000 | SQFT | $4.30 | $421,400 |
| Paint exterior hull, two coats @ $ 3.0 0/sq. ft x 98,000 sq. ft. | 98,000 | SQFT | $3.00 | $294,000 |
| Paint materials 98,000/300 sq. ft x $100/gallon x 2 coats | 654 | GALLON | $100 | $65,400 |
| d. Painting of interior new plating and scantlings, 2 coats epoxy primer 20,400 + 5,000 sq. ft x $ 3.00 sq. ft x 2 coats | 50,800 | SQFT | $3.00 | $152,400 |
| e. Red lead remediation of interior cut/burn at frames/bulk heads where | 10,000 | SQFT | $3.00 | $30,000 |
| New plating and scantling would be fitted | LS | ---------- | | $1,700,000 |
| Disposal of waste @ $ 360.00/55 gal. drum x 200 | 150 | DRUM | $360 | $54,000 |
| f. Completion washdown & cleaning of vessel | LS | ---------- | | $14,500 |
| **Subtotal B: Shipyard Costs** | | | | $27,804,550 |
| **C: Tugs, Pilots, Docking Master to/from Galveston assuming 8 hrs four tugs** | | | | $46,000 |
| **ROM Total 2nd Drydocking Costs** | | | | $27,850,550 |
| **3nd DRYDOCKING 30 YEARS** | | | | |
| **ROM Total 2nd Drydocking Costs** | | | | $27,850,550 |

# 6 EVALUATE THE SHIP'S CONDITION

## 6.1 CRITICAL PROBLEMS

The Battleship TEXAS (BB - 35) is a signature vessel in the annals of the U.S. Navy with historic significance nationally as well as internationally. As a national monument, the real work has been, and will always have to be, to ensure that the vessel is correctly preserved and displayed. This process will be, of necessity, an evolutionary one as new preservation technologies are developed and tested, proven good or discarded. The vessel's age, size and mass dictate a need for continuous and creative maintenance procedures.

This section of the report presents an assessment of the present condition of the vessel as obtained from a thorough and detailed inspection carried out from November, 2010 – January, 2011. Critical problem areas have been identified as those that merit immediate consideration before the re-floating of the vessel through dredging and the towing of the vessel to its temporary or final berthing configuration. Unless these issues are addressed satisfactorily before the vessel is re-floated or towed, there is significant risk in causing irreparable damage to the vessel. Other problem areas that have been identified primarily focus on the ongoing structural and cosmetic deterioration of the vessel, including the associated safety and environmental hazards, and which need to be addressed to extend the life of the vessel once it has been dry-berthed. This report should be read in conjunction with Lombardi (2010) and Possehl (2010) which document the Ultrasonic Testing (UT) and corrosion analysis results from a diving survey and the stability assessment of the vessel, respectively.

For reference to Figures and Sections in section 6 herein, please refer to Attachment E, Vessel Inspection and Assessment.

## 6.2 CRITICAL PROBLEMS

The critical problem areas observed during the inspection, highlighted in Figure 6-1 are as follows:

1. Outboard Blister Tanks (Section 5.1)

The outboard blister tanks were inspected and ultrasonic testing (UT) readings were taken of the shell plating on both sides of the vessel (Lombardi, 2010). The UT results showed severely wasted or holed plating throughout the length of the vessel on both Port and Starboard sides. Tugs cannot rest against the majority of the blister tank system on either Port and Starboard sides. Several tanks on the starboard side were inspected by an ISHOT 550 HD camera and the interior structural support members for the shell plating were either severely deteriorated or non-existent, and have separated from the armor belt above and shell plating below. This is cause for serious concern as no confidence can be placed upon the blister tanks or related structural members to support the ship during an intermediate docking interval with regard to a normal pierside fendering system (Possehl, 2010). Serious consideration must be given to the repair of the blister tank plating and scantlings before the vessel is re-floated, towed or moved into a dry-berth. This type of repair can be achieved before any dredging to re-float the vessel. Detailed repair recommendations are provided within the main body of the report.

2. Hold and Inner Bottom Tanks (Section 14)

The vessel is aground from Frame No. 10 to approximately Frame No. 129 and is freely flooding in many areas. A portion of the vessel's void, fuel and water tanks were also inspected. The lower 8 ft of inner bottom and hold are in an extremely deteriorated material condition and need to be rebuilt. Much of the interior scantlings have greater than 60 - 80% loss and are failing due to heavy weight loads (boilers, main engines, etc.). There is no transverse watertight integrity of the main bulkheads. The interior spaces forward of Frame No. 63 are generally in reasonable condition. The structural frames, bulkheads and foundations for the hold and inner bottom tanks aft of Frame No. 65 to the Stern are badly degraded. Aft of Frame No. 64 to Frame No. 135, all interior tanks contiguous to the centerline keel showed heavy to severe wastage, if not outright failure, in that the keel, longitudinal and transverse frames and watertight bulkheads are severely scaled with standing water and there is generally severe rust/scale present (Section 15.2, Section 15.4). The vessel's fuel tank steam heating coils and many valve manifolds are badly wasted/deteriorated and have failed in many areas. The rivet seams show severe wastage/failure as to plate lap seams and docking keel appendages. The Aft Emergency Diesel Room (Section 14.2.7.9) is in poor material condition and unsafe for personnel entry. Repairs to these deteriorated structural components should be undertaken with the vessel in its current slip and prior to any re-floating or towing. Detailed repair recommendations are provided within the main body of the report.

2a Boiler Rooms B-3 and B-4 (Section 13.2.2and Section 13.2.3)

The foundations for the boilers within the boiler rooms are starting to fail with signs of badly scaled or compressed plating and foundations. The floor for these boilers is completely wasted through in many areas allowing views within the underlying hold tankage with approximately additional 40 – 70 % wastage in places. The underlying support frames and longitudinals within the tankage in the hold and inner bottom is severely bent, totally wasted away or non-existent and showing ready signs of eventual collapse. The side shell on both sides appears fine with no leakage from outboard tankage, piping or manifolds.

2b Aft Trim Tanks D-12 and D-13 (Section15.4.1 Section 15.4.2)

This space is just below the steering room and originally supported the decks, stanchions and foundations above. This space was reportedly (according to TPWD staff) flooded for decades with salt water and has now deteriorated throughout to a dangerous degree. The tank shell plating exhibits greater than 80% loss with heavy leakage noted on the forward starboard side at the wind/waterline and to port opposite. An automatic pump is fitted to regularly dewater this space. There is heavy rust/scale throughout the compartment. Longitudinal Frames show greater than 80 % plate loss with heavy scale mostly in all portions of the space. There are badly tripped and distorted transverse frames throughout the space. The keel has greater than 80% plate loss and there is 12 inch of standing water from weeping rivets and bottom plating. The shell plating below the waterline in the Aft Trim Tanks D-12 & D-13 are continuously leaking, requiring a float-type bilge pump to be engaged at all time.

3. Engine Rooms (Section14.2.7, Section 14.2.7.1, Section15.3.1)

The main engine foundations (particularly the port side unit) have failed and are a serious structural and safety concern. The six tanks under the pair of main engines are freely flooding. Tank C-95 is flooded with 3 ft + of standing water and 3-4 in of oil and could not be inspected. Of concern is the foundation for this engine in that the weight of this structure depends upon the strength of the three underlying inner bottom tank scantlings. There is very little material left within the scantlings below (engine room floor, transverse frames, longitudinal frames, keel) the main engine. The engine's base foundation has also been impacted by corrosion. Other major components, foundations and platforms in this space are in acceptable condition but all suffer from a lack of support from the inner bottom tanks. The Fore and Aft bulkheads are holed due to corrosion. It is recommended that repairs to these tank and engine bed scantlings and bulkheads be performed before the vessel is towed. This type of repair can be achieved before dry-berthing.

4. Chief Petty Officer (CPO) Spaces (Section11.1, 11.2 and 1.3)
There is severe deterioration Aft of Frame No. 120 up to the Third Deck. The tankage, trim tanks and upper deck main supports (vertical main stanchions, from shell plating/keel up to the bottom of the Second Deck), which includes the CPO spaces on Half Deck after Frame No. 115 have failed, or are soon to fail. The bulkheads, transverse web frames, floors and keel are in poor material condition and in jeopardy of failure. The vertical support stanchions in the CPO Quarters supporting the Second Deck are severely corroded with wasted pedestal bases. The deck itself is severely wasted and unsafe in many areas. The side shell tanks are entirely wasted away. The transverse bulkheads are non-watertight and are holed. Tugs cannot rest against the stern plating on either the Port or Starboard sides, nor can they exert any pull on the stern/main-deck cleats, bollards and chocks. These must be rebuilt prior to any movement of the vessel. Detailed repair recommendations are provided within the main body of the report.

5. Steering Gear, Steering Room and Overhead Void Spaces (Section 13.3.13, 13.3.16, 13.3.17)
The steering room spaces contain the main electrical and hydraulic control equipment powering the steering rams in the next space aft. An antique quad of wooden steering wheels are fitted, but are no longer attached to the steering assembly linkage. This space also contains the extremely heavy pair of hydraulic rams connected to the rudder post that steers the ship; these are very robust and locked in position to a 15 degree starboard turn.

The condition of the space is poor structurally and poor cosmetically. The deck is wasted and holed, and inspection by gauging showed wastage greater than 60-70% over a wide area. Transverse web frames have failed entirely. The overhead sheathing, support framing, bulkheads and vertical stanchions supporting the turtleback on the overhead sheathing have failed, or are soon to fail, due to corrosion. The deck itself is poorly supported by the transverse frames and stanchions within the Trimming Tank D-12. This entire area needs to be rebuilt to withstand the movement of the ship and to impart any strength while on the keel blocks to support everything under the Third Deck. Detailed repair recommendations are provided within the main body of the report.

6. Asbestos, PolyChlorinated Biphenyls (PCB), Lead Paint and Other Contaminants
Considering the age and vintage of this ship, it can be assumed that asbestos, PCBs, and lead paint will be found on the ship. While extensive asbestos remediation was completed and documented as per Texas Parks and Wildlife (TPWD), any future maintenance and/or repairs done to the ship should factor in the possibility of friable asbestos being present either at the onset of the activities or as a possible consequence. A similar assumption can be made in reference to lead paint throughout the ship. PCBs prove more complex as the construction period and first half of the ship's life were PCB-free, it was only

about 1929 that PCBs would have had the potential of occurring associated with new electrical installations. A more detailed investigation and testing regime might be necessary to determine potential PCB contamination within the ship. Any future ship repair work should include testing and determination of potential contaminants in the area of work.

## 6.3 OTHER PROBLEM AREAS

The vessel's topsides above main deck are generally in good repair. The problems associated with the vessel's exterior include poor or non-existent drainage, failed paint system, rust and scale on exposed structure and the wooden deck. This is not considered a serious problem at this juncture, and will not require repairs before the vessel is towed to its dry-berth, but will likely become a more serious issue in the future. The main problem areas observed during the inspection are as follows:

1. Topside Hamper (Section 4)

The vessel's topside hamper above the main deck suffers from too much standing water and drainage issues. In particular, the armored citadel decks and both masts suffer from long term neglect as to poor steel plate replacement installation and failed paint coatings with the result that serious corrosion issues are now present (e.g. Figure 16). These conditions are found throughout the vessel's topside hamper. Plates and seams have opened up allowing water to penetrate the lower decks causing rust/scale corrosion. This is exacerbated, in some cases, by blocked drains, broken/missing drain piping and areas that have no drains where standing water accumulates (e.g. Figure 17). Detailed repair recommendations are provided within the main body of the report.

2. Paint Coating System

The continued utilization of silicon alkyd paint on the vessel's topsides will incur a severe maintenance penalty due to the fact that this type of paint system will require re-coatings every other year or so. The use of a modern coating system (such as one provided within Appendix C of this Hull Survey report) will greatly improve retention of sub-surface steel structure and greatly decrease maintenance costs. Detailed repair recommendations are provided within the main body of the report.

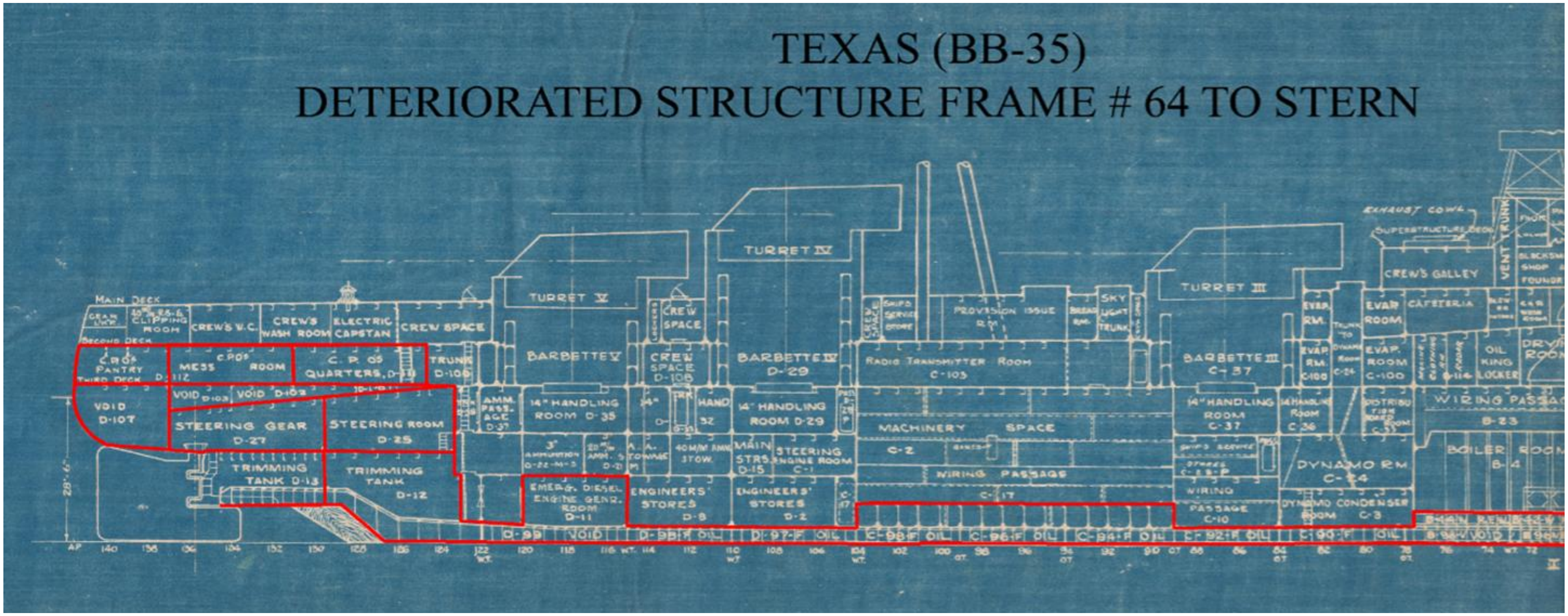
3. Main and Upper Level Wooden Decks (Section 4.11, 4.12)

The vessel's wooden deck system on main deck and other upper level decks are in need of continued repair and maintenance as the welded steel attachment studs (of threaded mild steel) are starting to rust away and deteriorate the planking, seam/bedding caulking and steel deck. The caulking within the seam between both planks has pulled away in many areas of the deck. This has become problematic now as more water migrates to the area between wooden and steel deck. There is no easy fix to this problem (short of an entire deck replacement) and continuous repairs are ongoing to address this problem. Detailed repair recommendations are provided within the main body of the report.

4. Pest Control

The effects of animals (including reportedly, raccoons) aboard the ship are evident. The effects of guano from pigeons and other birds and animals are already causing wastage of paint systems and resultant rust/scale of steel structure. The repair and placement of screens in gun barrels, overboard discharges and other favorite nesting areas, and other pest control strategies aboard should remedy the ongoing problem. Repair recommendations are provided within the main body of the report.

**Figure 6-1: TEXAS BB-35 Critical Areas**



# 7 COORDINATE REGULATORY REVIEWS AND REQUIREMENTS: PUBLIC INVOLVEMENT PLAN

Stakeholder outreach activities during Phase I included:

I. Stakeholder Workshop Planning and Facilitation
II. Internet Communications Support
III. Audiovisual Production

Stakeholder outreach activities during Phase I provided a sound foundation for Phase II stakeholder communications required by the National Historic Preservation Act (NHPA) consultation process and the National Environmental Policy Act (NEPA) public involvement process. These activities included initial stakeholder contact, implementation of a stakeholder workshop, collection and documentation of stakeholder comments, audiovisual presentations, graphic design of key printed informational pieces, and project website support functions.

I. Stakeholder Workshop Planning and Facilitation

Following consultation with the Texas Parks and Wildlife Department (TPWD) lead federal agency for this project, the Department of Navy Naval Sea Systems Command (NAVSEA), a stakeholder workshop was planned to initiate key stakeholder communications. This workshop was hosted on May 20, 2011, from 9:00 a.m. to 12:00 p.m. The workshop was hosted at the DuPont Employee Recreation Association Clubhouse, located at 12029 Strang Road, La Porte, Texas.

The workshop provided key stakeholders with a very early opportunity to participate in project planning prior to the consultation process required under NHPA. Attendance at the stakeholder workshop was by invitation, and attendees were mailed formal invitation letters. Complete documentation of this workshop, including the invitation database, is available for reference in the Stakeholder Workshop Summary Report included in Attachment F. Video documentation of the workshop was also produced and provided as part of the formal project record. The video was provided to NAVSEA and other project team members who could not be present at the meeting. During Phase II the video will be publicly accessible online.

a. Workshop Organization and Implementation

This workshop-style meeting was hosted to present information about the proposed project and to provide an opportunity for stakeholder participation at the outset of the project planning process. The workshop was structured in three parts:

- A brief TPWD-led project presentation;
- An organized group brainstorming session;
- Individual comment gathering (written and oral); and
- Sharing of individual and group comments with the attendees (oral).

The workshop was organized and laid out with five color-coded tables for attendees, including red, yellow, orange, blue, and green. Attendees were pre-assigned to color-coded tables according to their individual expertise and project interests. Resource agency representatives, elected officials, and public interest groups were equally represented at each table.

Upon arrival, workshop attendees were welcomed to sign in using an attendee card, which was designed to capture attendee contact information for future reference. Attendees also received a name tag and color-coded seating assignment. Twenty-four (24) attendees attended the workshop.

Attendees were provided with informational 11" X 17" printed pieces at each of their tables. These collateral materials are included in the Stakeholder Workshop Summary Report in Attachment F. Battleship TEXAS Dry Berth Project representatives from TPWD, AECOM, and Crouch Environmental Services, Inc. (CESI) were available throughout the workshop to speak one-on-one with attendees.

The workshop began promptly at 9:00 a.m., facilitated by Kay Crouch of CESI. Workshop attendees and project staff briefly introduced themselves, and Ms. Crouch outlined the goals and objectives of the workshop. Neil Thomas, Battleship TEXAS Dry Berth Project Manager for TPWD, gave a PowerPoint presentation describing an overview of the proposed project. This presentation provided project background information, illuminated key considerations, and described the project process.

Following the presentation, attendees were provided with individual comment forms to document comments, questions, and considerations for the project. A total of 16 individual comments were formally submitted through comment forms and email. Written comments were accepted through May 30, 2011. All comments received were recorded and documented in the Stakeholder Workshop Summary Report in Attachment F.

Ms. Crouch then led the workshop attendees in a brainstorming session organized by attendees at individual tables. Each table was provided with a “Group Consensus Plans and Recommendations” form, and attendees were invited to brainstorm in order to answer the following questions as a group:

- What would you do with the Battleship TEXAS?
- Where would you consider moving her, if you were to move her elsewhere?
- Are you in favor of leaving the Battleship TEXAS in her current location?
- What is your impression of the idea of dry berthing the ship?
- What other valuable feedback do you have for us?

Each table elected a scribe and spokesperson to document and present their group findings, ideas, and concerns. The spokesperson designated by each table presented their findings orally. All group comments were recorded and are documented in the Stakeholder Workshop Summary Report in Attachment F.

Before the conclusion of the workshop, attendees were given fifteen minutes to provide oral comments individually. These comments were simultaneously recorded in writing on a large presentation screen to ensure accuracy, and this documentation is included in the Stakeholder Workshop Summary Report in Attachment F. The meeting adjourned promptly at 12:00 p.m.

All meeting materials developed for this workshop are provided in the Stakeholder Workshop Summary Report in Attachment F.

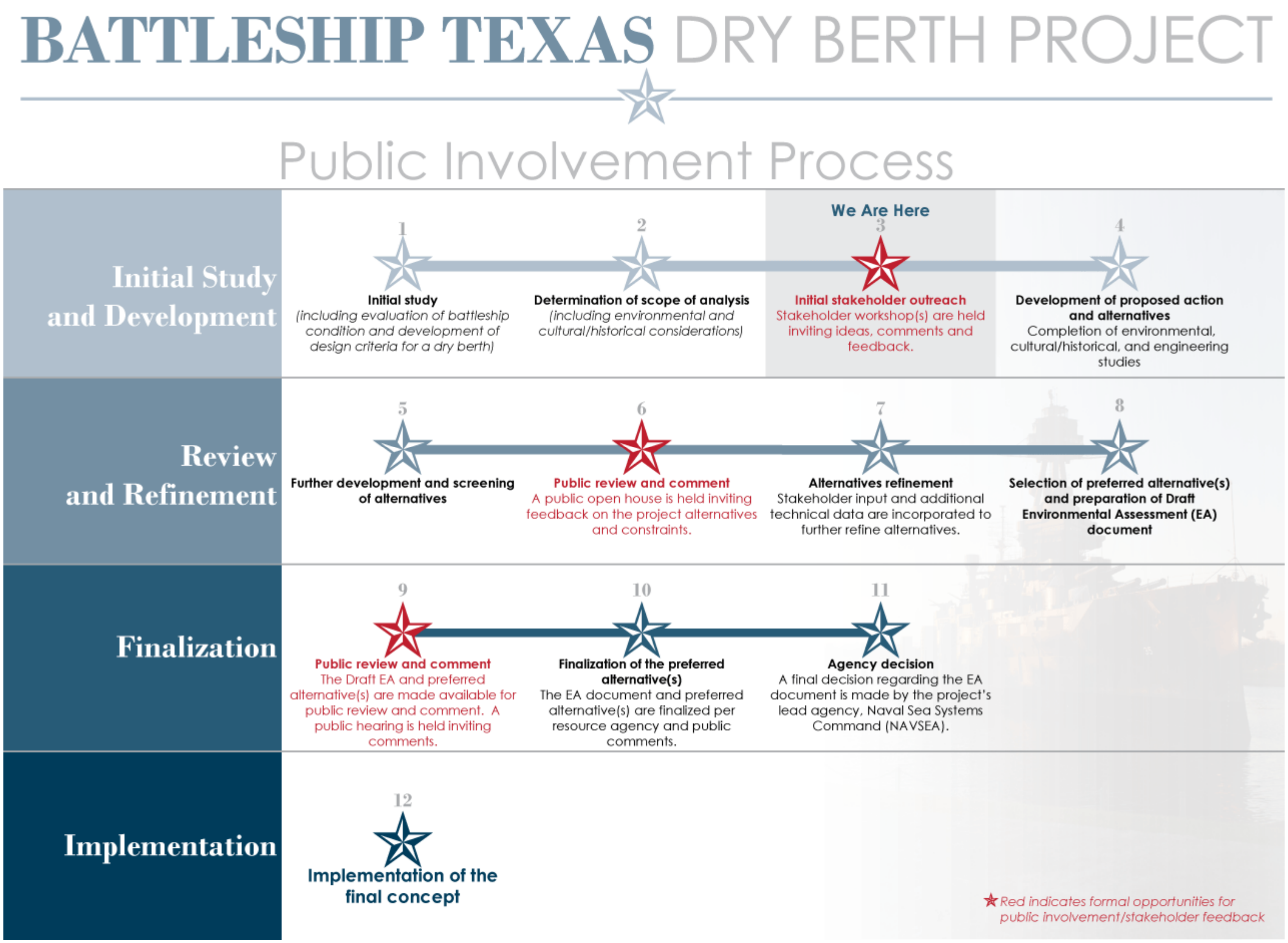
b. Stakeholder Feedback

Comments were received in writing through May 30, 2011. The comment database, completed comment forms, and other feedback are documented in the Stakeholder Workshop Summary Report available in Attachment F.

A majority of the comments received were in favor of a dry berth at the ship's existing location adjacent to the San Jacinto Battleground State Historic Site, while other comments expressed a desire to relocate the ship to an alternative site. Attendees were concerned with the risk associated with moving the Battleship TEXAS, as well as the availability of funding sources if the ship is moved from its current location. Requests for further information included alternatives to dry berthing, consideration of alternative locations, and access to technical studies when available. Alternative locations identified include Galveston, Baytown, and the Texas Coast in general.

A project schedule was developed for public reference for the Battleship TEXAS Dry Berth project including Phase I and Phase II

**Figure 7-1: Public Involvement Schedule**



II. Internet Communications Support

The stakeholder outreach team provided internet communications support to TPWD as needed for the Battleship TEXAS Dry Berth Project. This included the following services:

- Web development and design recommendations
- Establishment of a project domain (www.dryberthTEXAS.com) and associated project email addresses (info@dryberthTEXAS.com, rsvp@dryberthTEXAS.com, consultingparties@dryberthTEXAS.com)
- Video hosting coordination and recommendations
- Project FTP site hosting and facilitation (ftp.dryberthtexas.com)

The project team was available throughout Phase I to TPWD project management and communications staff to coordinate needs for the project website. The project domain, www.dryberthTEXAS.com, was established to provide stakeholders with a direct project address that redirects to the TPWD project site (http://www.tpwd.state.tx.us/state-parks/parks/battleship-texas-dry-berth-project/battleship-texas-dry-berth-project). Formal project email addresses were also established for official correspondence from project staff to stakeholders and consulting parties.

The stakeholder outreach team also supplied internal support services, including hosting of videos and a project FTP site, for access and use by the entire project team. These support functions will continue throughout Phase II.

III. Audiovisual Productions

The stakeholder outreach team produced several audiovisual presentations throughout the course of Phase I, including:

- May 20, 2011 Stakeholder Workshop Video Documentation (Runtime: 1 hour 11 minutes)
- TPWD-AECOM Phase I Presentation (Runtime: 25 minutes)

Video presentations prepared during Phase I included use of video documentation from stakeholder meetings, three-dimensional computer-generated models, computer-generated animations, expert interviews, design figures, high-definition video footage of the Battleship TEXAS State Historic Site and the San Jacinto Battleground State Historic Site, as well as professional narration.

The video serves as an unparalleled educational tool for projects of this nature, distilling complex project information into an appealing and accessible format. Video presentations serve the project team by providing a point of consistent, targeted communication in a professional and easily distributed format. The Phase I presentations (full-length and abridged) will be updated to serve the project team, interested stakeholders, consulting parties, and the general public throughout the life of the dry berth project.

# 8 IDENTIFY AND MAKE PRELIMINARY DESIGN PREPARATIONS /COST ESTIMATES FOR A TEMPORARY LOCATION TO DOCK THE TEXAS DURING CONSTRUCTION OF THE DRY BERTH

Halcrow, a sub-consultant to AECOM, was asked to evaluate:

- Structural concepts for the temporary berthing of the TEXAS on the south side of the existing battleship basin.
- Suitability of existing offsite terminal facilities on the ship channel as temporary berthing for the TEXAS.

The dry berth construction is estimated to have a duration of 18 to 24 months and it is desirable to be able to continue to operate the vessel as a museum and showcase for the public while it is at its temporary berth location.

**Figure 9-1: Battleship TEXAS**

There are three basic concepts for the temporary berthing of the vessel:

- Leaving the vessel in its current location during construction while building an adjacent permanent dry berth.
- Constructing a temporary berth on the ship channel adjacent to and south of the current wet berth location.
- Utilizing an existing berth at an offsite location along the ship channel.

Leaving the vessel in its current location would add little cost as a temporary berth and the vessel would be able to function as a museum. There may be some incidental costs associated with utility relocations, but that is not addressed here and would be considered negligible relative to the cost of a temporary berth facility.

## 8.1 TEMPORARY BERTHING STRUCTURES SOUTH OF EXISTING WET BERTH

Construction of a new temporary berth adjacent to and south of the existing wet berth is desirable due to its proximity to keep the vessel functioning as a museum. There are several structural concepts that were evaluated for constructing a temporary berth.

The battleship site has an existing anchored sheet pile wall along the south side of the property adjacent to the ship channel. The wall uses tie rods to pile supported anchors points which are located about 40 feet inland. Water depth along the wall is about 10 feet and the wall toe penetrates to -26.0'. See Attachment G/Figures 1 and 2.

There are several proposed dry berth options using a cofferdam/king pile wall to create the dry berth closure. Structural concepts for the temporary berth would consist of constructing a wall connected to the cofferdam/king pile wall. Concepts 1, 2 and 3 extend the cofferdam/king pile alignment with sheet pile wall and concepts 4 and 5 connect to the cofferdam/king pile but extend toward the south in a different alignment to take advantage of the existing sheet pile wall which reduces significantly the amount of required dredging.

Five temporary structural concepts were investigated for the construction of the temporary berth.

- Concept 1: Steel anchored sheet pile bulkhead behind south sheet pile wall
- Concept 2: Cantilevered sheet pile bulkhead behind south sheet pile wall
- Concept 3: Soil anchored sheet pile bulkhead behind south sheet pile wall
- Concept 4: Cantilevered sheet pile bulkhead waterside of south sheet pile wall
- Concept 5: Soil Anchored sheet pile bulkhead waterside of south sheet pile wall

For alternative concepts 1 to 5 plans and sections, see Figures 3 thru 12 in Attachment G/Appendix A.

### 8.1.1 CONCEPT 1: ANCHORED SHEET PILE BULKHEAD BEHIND SOUTH SHEET PILE WALL

This concept consists of:

- Steel anchored sheet pile headwall
- Tie rods spaced at approximately 12 feet connecting headwall to anchor wall
- Sheet pile anchor wall located at 80 feet for headwall

The location of the tie rods would need to be planned in order not to intercept the existing tie back system. This concept disturbs 40 feet of property beyond the existing tie back system and is therefore undesirable because of the probable existence of cultural artifacts in the area. The bulkhead is built behind the existing wall requiring its demolition in order to maintain the alignment with the dry berth cofferdam/king pile wall. See Attachment G/ Figures 3 and 4.

### 8.1.2 CONCEPT 2: CANTILEVERED SHEET PILE BULKHEAD BEHIND SOUTH SHEET PILE WALL

This concept consists of a cantilever pipe AZ combined sheet pile headwall built behind the existing wall requiring its demolition in order to maintain the alignment with the dry berth cofferdam/king pile wall. Since it is built behind the existing wall, it would affect several feet of the property that would impact the cultural artifacts in the area. See Attachment G/ Figures 5 and 6.

### 8.1.3 CONCEPT 3: SOIL ANCHORED SHEET PILE BULKHEAD BEHIND SOUTH SHEET PILE WALL

This concept consists of a soil anchored sheet pile headwall constructed behind the existing wall requiring its demolition. It also maintains the alignment of the dry berth cofferdam/king pile wall. Since it is built behind the existing wall it would affect several feet of the existing shoreline thus impacting the cultural artifacts that are believed to be in the area. However, the soil anchors would be below the elevation of the cultural artifacts in the area. See Attachment G/ Figures 7 and 8.

### 8.1.4 CONCEPT 4: CANTILEVERED SHEET PILE IN FRONT OF SOUTH SHEET PILE WALL

This concept consists of a cantilever pipe AZ combined sheet pile headwall built waterside of the existing wall allowing it to remain in place once the ship is moved to the dry berth. It does not maintain the alignment of the dry berth cofferdam/king pile wall. Since it is built waterside of the existing wall it would not affect the existing property or the cultural artifacts in the area. See Attachment G/Figures 9 and 10.

### 8.1.5 CONCEPT 5: SOIL ANCHORED SHEET PILE BULKHEAD IN FRONT OF SOUTH SHEET PILE WALL

This concept consists of a soil anchored sheet pile headwall constructed waterside of the existing wall allowing it to remain in place once the ship is moved to the dry berth. It does not maintain the alignment of the dry berth cofferdam/king pile wall. Since it is built waterside of the existing wall it would not affect the existing or the cultural artifacts in the area. See Attachment G/ Figures 11 and 12.

### 8.1.6 COST ESTIMATE SUMMARY OF TEMPORARY ADJACENT BERTH CONCEPTS

A Rough Order of Magnitude (ROM) cost estimate for the five investigated structural concepts of a temporary berth located south of the battleship existing wet berth basin is summarized in Table 9-1:

**Table 9-1: ROM Cost for Temporary Adjacent Berthing Concepts**

| TEMPORARY BERTHING CONCEPTS FOR TEXAS | | | |
|---|---|---|---|
| Structural Concept | Type of Temporary Bulkhead | Location South of Existing Battleship TEXAS Basin | ROM Cost |
| Concept 1 | Steel Anchored | Behind Existing Bulkhead | $27,000,000 |
| Concept 2 | Cantilever | Behind Existing Bulkhead | $28,000,000 |
| Concept 3 | Soil Anchored | Behind Existing Bulkhead | $27,000,000 |
| Concept 4 | Cantilever | Waterside of Existing Bulkhead | $15,000,000 |
| Concept 5 | Soil Anchored | Waterside of Existing Bulkhead | $14,000,000 |

### 8.1.7 EXISTING OFFSITE TEMPORARY BERTHING FACILITIES

Several existing offsite docks were investigated as possible temporary berthing facilities for the TEXAS. This would require the vessel to be towed several miles to the temporary location but avoids the construction costs of building a temporary berth. The following locations were investigated as potential temporary berths:

- Port of Houston Turning Basin
- Barbour's Cut Container Terminal
- Greens Bayou
- Bayport Cruise Terminal

Distances from San Jacinto to the temporary berth locations are shown in the Table 9-2:

**Table 9-2: Distances from San Jacinto to the Temporary Berth Locations**

| Distance from San Jacinto to | Naut. Miles |
|---|---|
| Port of Houston Turning Basin | 14.0 |
| Barbours Cut Container Terminal | 10.5 |
| Greens Bayou | 4.7 |
| Bayport Cruise Terminal | 12.5 |

The hull structural survey showed that blister tanks on the vessel have deteriorated significantly and will not support the forces from typical fendering on the dock. Therefore, it is recommended that a bracket be manufactured to simulate the existing fendering to the monopiles or that monopiles be installed to accept the vessel brackets.

#### *8.1.7.1 PORT OF HOUSTON TURNING BASIN*

The Port of Houston Turning Basin has several docks that could be used as a temporary berth. The fendering at this location would require modification to accept the vessel. Since the blister tanks on the vessel are not adequate to support the fender loads, it is recommended that a fender frame be constructed that could hang over the existing dock and allow the vessel to be moored to its present clamps. Port of Houston Authority is the owner of the facilities with strict procedures of security and safety, therefore a safe entrance and exit would be required for the public to access the vessel. This location would require potable water and electric power. The Port of Houston was not agreeable to accepting the vessel at this location. Therefore, the costs were not estimated and it is recommended that the location be dropped from further consideration as a temporary berth for the vessel. See the photos below and Figure 13 in Attachment G/Appendix A.

**Figure 9-2: Dock at Turning Basin**

Figure 9-3: Dock at Turning Basin


Figure 9-4: Dock at Turning Basin

Figure 9-5: Dock at Turning Basin

### 8.1.7.2 BARBOURS CUT CONTAINER TERMINAL

The end of Barbour's Cut container terminal is acceptable to berth the TEXAS. The fendering at this location would require modification to accept the vessel. Since the blister tanks on the vessel are not adequate to support the fender loads, it is recommended that a fender frame be constructed that could hang over the existing dock and allow the vessel to be moored to its present clamps. Port of Houston Authority is the owner of the facilities with strict procedures of security and safety, therefore a safe entrance and exit would be required for the public to access the vessel. This location would require potable water and electric power. The Port of Houston was not agreeable to accepting the vessel at this location. Therefore, the costs were not estimated and it is recommended that the location be dropped from further consideration as a temporary berth for the vessel. See the photos below and Figure 14 in Appendix A.

Figure 9-6: Dock at West End of Barbour's Cut

Figure 9-7: Dock at West End of Barbour's Cut


Figure 9-8: Dock at West End of Barbour's Cut

### 8.1.7.3 GREENS BAYOU

Greens Bayou terminal is not adequate structurally to support the vessel forces for mooring and berthing the TEXAS. Therefore, the costs were not estimated and it is recommended that the location is not subject to further investigation as a temporary berth for the vessel. See the photos below.

Figure 9-10: Greens Bayou Dock

Figure 9-11: Greens Bayou Dock

Figure 9-12: Greens Bayou Dock


Figure 9-13: Greens Bayou Dock


Figure 9-14: Greens Bayou Dock

### 8.1.7.4 BAYPORT CRUISE TERMINAL

The Bayport Cruise Terminal is an ideal location for a temporary lay berth for the Battleship TEXAS. The facility is currently unoccupied. The Port of Houston Authority has been contacted and was initially agreeable to berthing the vessel there assuming negotiated terms are reached. This option would be contingent upon the facility being available at the time of the dry berth construction.

The facility consists of a building that is used for processing cruise passengers, an adjustable gangway, and over 1000 feet of dock with 100 tonnes mooring bollards spaced at 50 feet along the dock. The available water depth is 31 feet. There is also ship-to-shore water supply and a separately metered electrical line that was used in the construction of the facility. Since the TEXAS is much shorter than a cruise vessel, the vessel could be berthed at either end of the dock allowing tourists to bypass the building and enter thru security gates which are provided at the end of the building for service vehicles to the dock. This would require the purchase of a small gangway to access the vessel but would result in saving lay berth fees by not using the building.

Since the vessel blister tanks are not adequate in supporting the vessel against the fenders provided at the cruise terminal, the best alternative for mooring would be to provide a separate structure or monopoles in front of the berth to attach the TEXAS clamps. This would not be permanently attached to the dock and could easily be removed at the end of the temporary berthing term.

The use of this facility as the temporary berthing location for the vessel would require miscellaneous improvements that are estimated to cost approximately $1,000,000.

See the photos below and Figure 15 in Attachment G/Appendix A.

Figure 9-15: Bayport Cruise Terminal

Figure 9-16South End Bayport Cruise Terminal

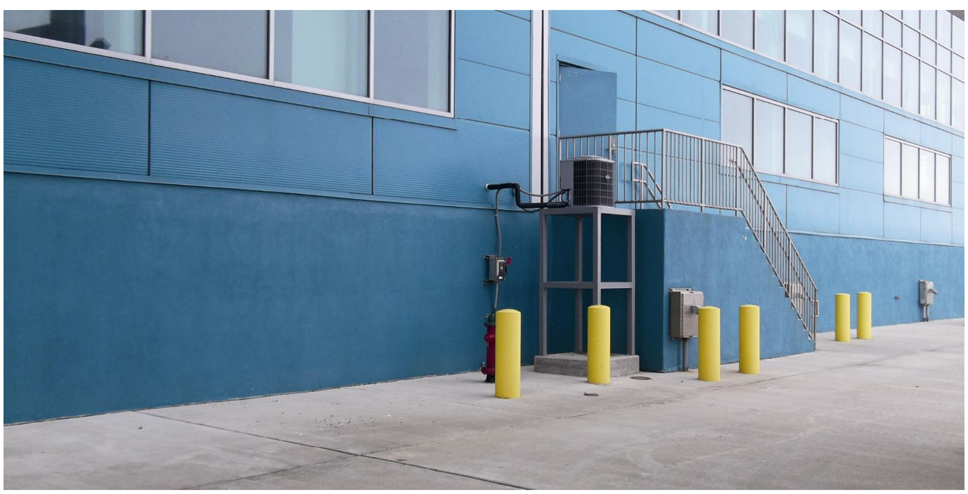


Figure 9-17: Exit Stair from Building to Dock

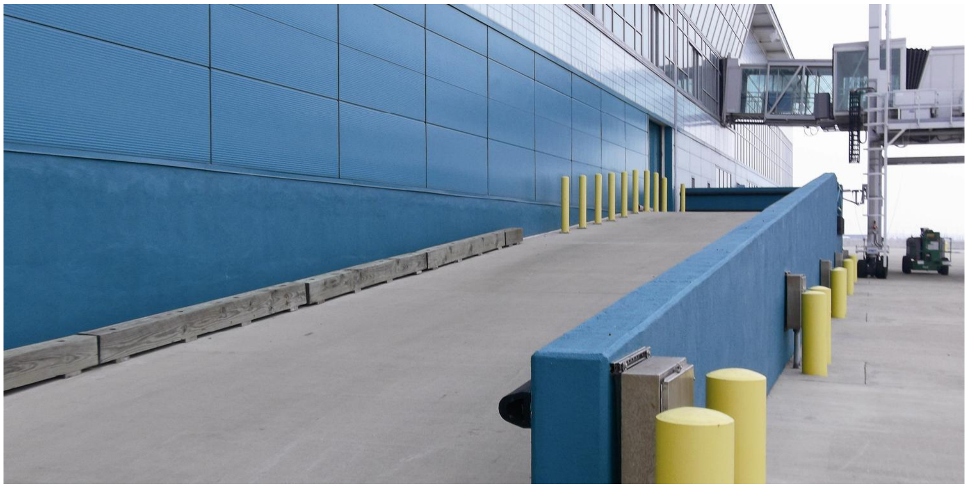


Figure 9-18: Exit Ramp from Building to Dock

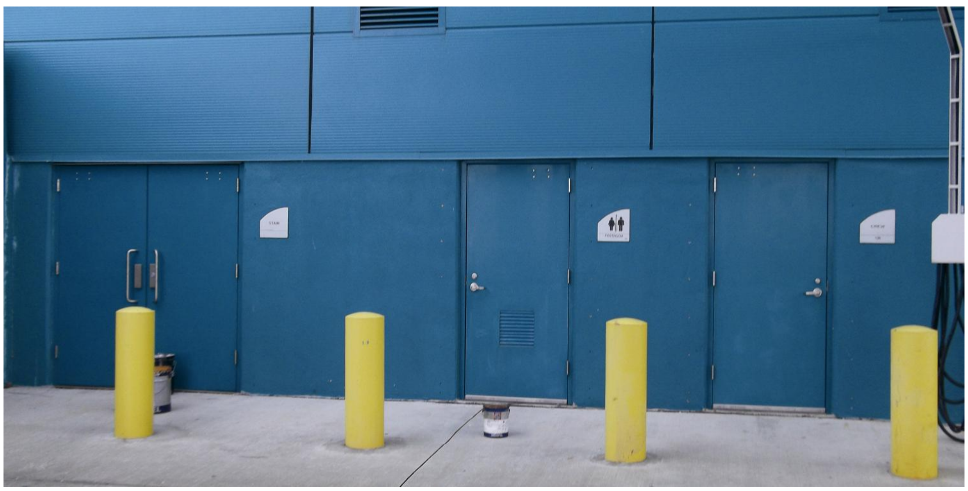


Figure 9-19: Exterior Facilities

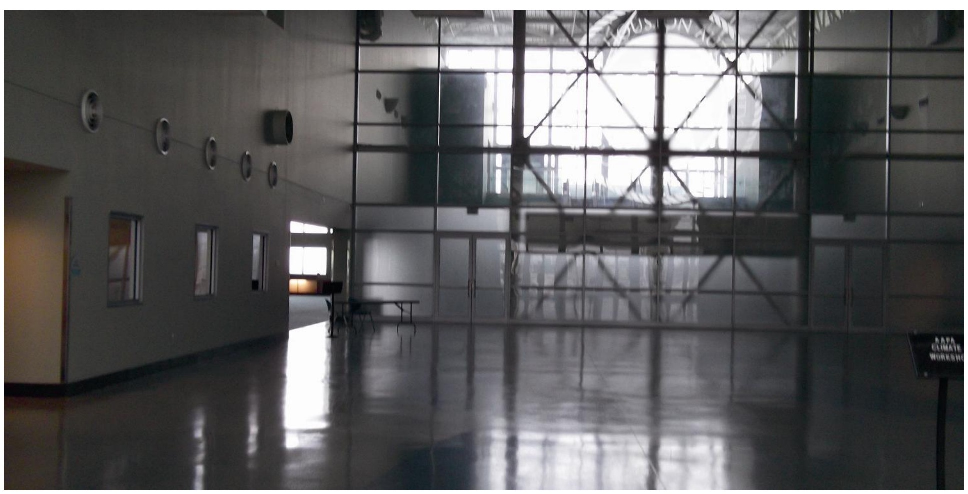


Figure 9-20: Large Entrance Room

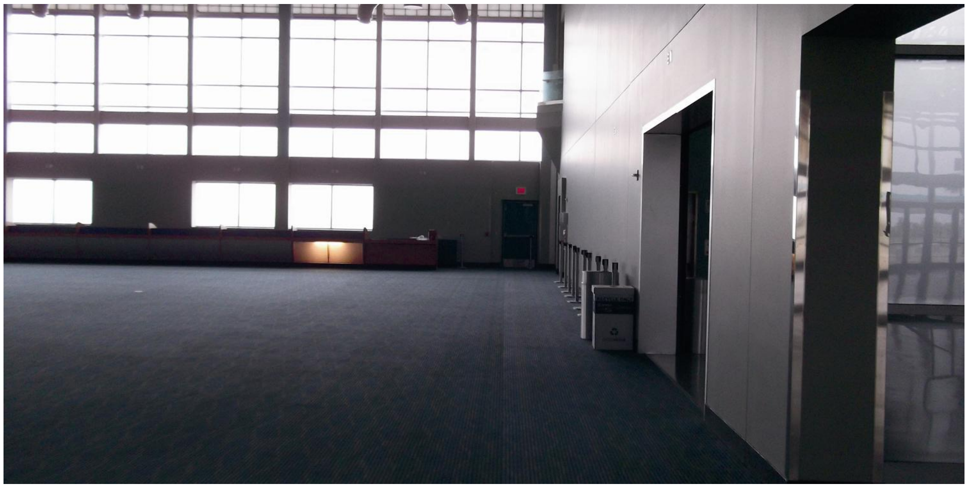


Figure 9-21: Large Processing Room (Exit door is to stair to dock above)

Figure 9-22: Interior Facilities


Figure 9-23: Ship-to-Shore Potable Water

Figure 9-24: North Security Gate Access to Dock

Figure 9-25: South End of Dock

Figure 9-26: South Security Gate Access to Dock

Of the four possible existing temporary berthing locations investigated, the most feasible is the Bayport Cruise Terminal.

### 8.1.8 EXISTING OFFSITE TEMPORARY BERTHING SUMMARY

A summary of the findings for the investigated existing offsite temporary berthing locations is shown in Table 9-3:

**Table 9-3: Existing Offsite Temporary Berthing Location**

| EXISTING TEMPORARY BERTHING LOCATIONS | |
|---|---|
| Existing Berthing Location | Findings |
| Port of Houston Turning Basin | Port of Houston was not agreeable to having the TEXAS. Would require safe entrance and exit to visiting public. |
| Barbours Cut Container Terminal | Port of Houston was not agreeable to having the TEXAS. Would require safe entrance and exit to visiting public. |
| Greens Bayou | Not Adequate Structurally |
| Bayport Cruise Terminal | Port of Houston may be agreeable to having the TEXAS. Substantial risk to tow the TEXAS . Exposed location to waves. Exposure during hurricane which could damage the TEXAS. |

# 9 PRESENTATION OF OPTIONS AND RECOMMENDATIONS TO TPWD STAFF AND OTHERS

Presentation of the dry berth options was given to TPWD in Austin on August 4, 2011. There was a verbal and video presentation and a Q&A session.

AECOM

5757 Woodway Drive
Suite 101 West
Houston, Texas  77057-1599

Jerry Farhat
713.267.2756